

AD-A060 062

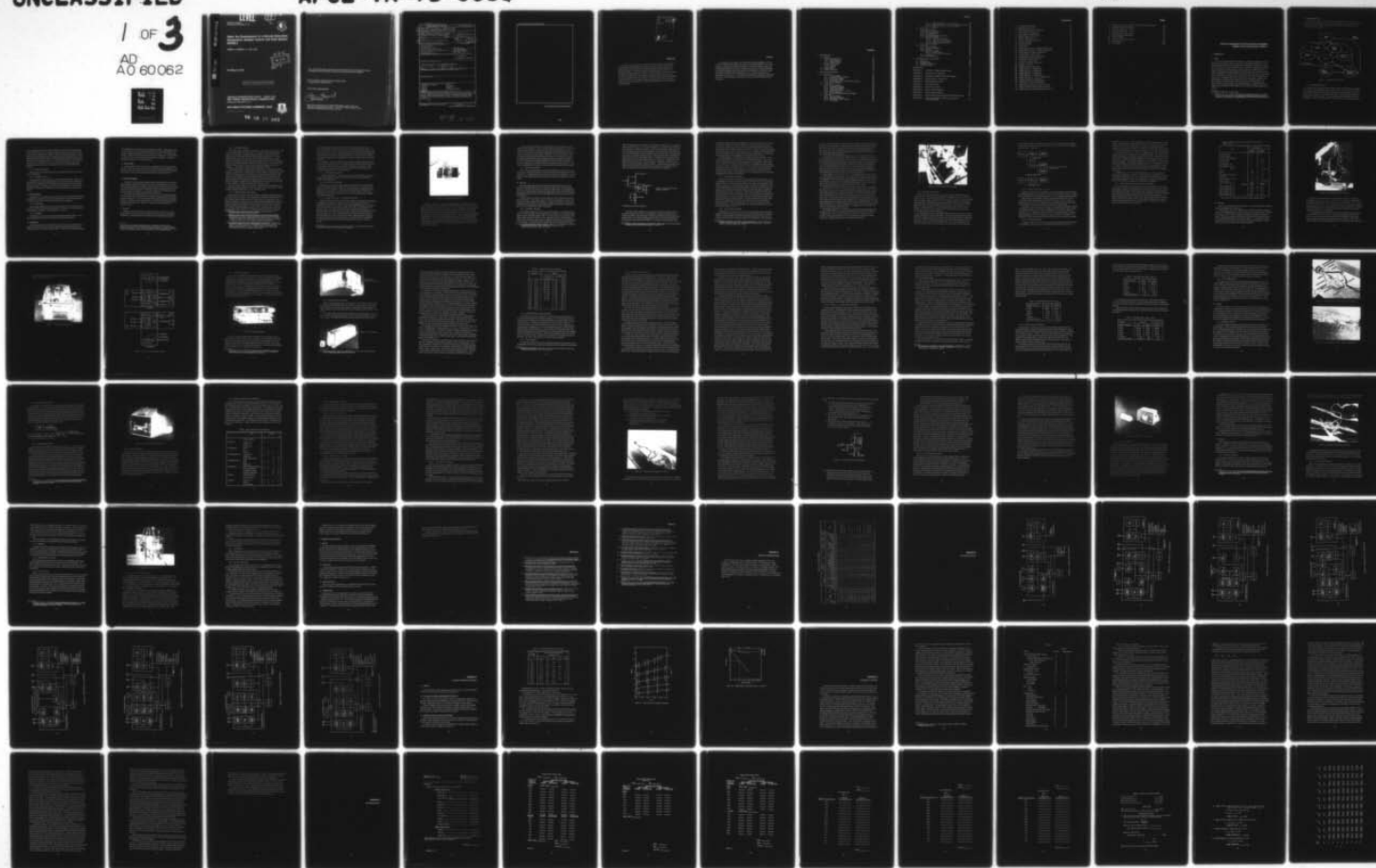
AIR FORCE GEOPHYSICS LAB HANSCOM AFB MASS  
ABOUT THE DEVELOPMENT OF A SECOND GENERATION ATMOSPHERIC SAMPLE--ETC(U).  
MAR 78 R H CORDELLA  
AFGL-TR-78-0065

F/G 4/1

UNCLASSIFIED

NL

1 OF 3  
AD  
A0 60062



DDC FILE COPY

AD A060062

LEVEL

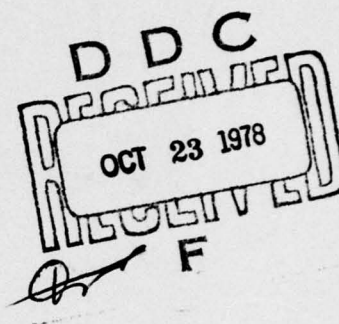
192

AFGL-TR-78-0065  
INSTRUMENTATION PAPERS, NO. 264



## About the Development of a Second Generation Atmospheric Sampler Control and Data System: SCADS-2

ROBERT H. CORDELLA, Jr., Capt, USAF



16 March 1978

Approved for public release; distribution unlimited.

AEROSPACE INSTRUMENTATION DIVISION PROJECT AE30  
AIR FORCE GEOPHYSICS LABORATORY  
HANSCOM AFB, MASSACHUSETTS 01731

AIR FORCE SYSTEMS COMMAND, USAF



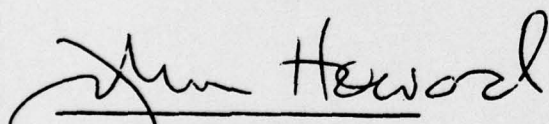
AIR FORCE (1) JULY 6, 1978--664

78 10 13 067

This report has been reviewed by the ESD Information Office (OI) and is releasable to the National Technical Information Service (NTIS).

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

  
Chief Scientist

Qualified requestors may obtain additional copies from the Defense Documentation Center. All others should apply to the National Technical Information Service.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM	
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. REPORT TYPE	4. CATALOG NUMBER
AFGL-TR-78-0065	AFGL-IP-264		
5. TITLE (and Subtitle)		6. TYPE OF REPORT & PERIOD COVERED	
ABOUT THE DEVELOPMENT OF A SECOND GENERATION ATMOSPHERIC SAMPLER CONTROL AND DATA SYSTEM: SCADS-2		Scientific. Final.	
7. AUTHOR(s)		8. PERFORMING ORG. REPORT NUMBER	
Robert H. Cordella, Jr., Capt, USAF		IP No. 264	
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. CONTRACT OR GRANT NUMBER(s)	
Air Force Geophysics Laboratory (LCC) Hanscom AFB, Massachusetts 01731		AE306801	
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE	
Air Force Geophysics Laboratory (LCC) Hanscom AFB, Massachusetts 01731		16 March 1978	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		13. NUMBER OF PAGES	
		248	
		15. SECURITY CLASS. (of this report)	
		Unclassified	
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report)			
Approved for public release; distribution unlimited.			
12 237 p. / 9 Final rept.			
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)			
18. SUPPLEMENTARY NOTES			
639205			
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)			
Atmospheric sampling      Altitude Sensors                      Temperature Control                      Pressure Encoder                      Flow rate samplers Telemetry			
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)			
This report documents the development of an atmospheric sampling control and data acquisition system (SCADS) for the Department of Energy's high-altitude, balloon-borne monitoring program. The period documented spans 5 calendar years ending with 1977. Sources for technical information are referenced.			

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

409 578  
78 10 13 067

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)



SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

ACCESSION for	
NTIS	White Section <input checked="" type="checkbox"/>
DDC	Buff Section <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
BY	
DISPATCHED TO	
A	23

## Foreword

The purpose of this report is to document the development of a second generation atmospheric sampling control and data acquisition system (SCADS) for the Energy Research and Development Administration high-altitude, balloon-borne monitoring program. The instrumentation is documented in Project Ash Can Atmospheric Sampling Handbook, Volume II: Instrumentation, SCADS-2. It should be noted that during system development two agencies involved changed names. Air Force Cambridge Research Laboratories (AFCRL) became Air Force Geophysics Laboratory (AFGL) and the Atomic Energy Commission (AEC) became first the Energy Research and Development Administration (ERDA) and then the Department of Energy (DOE).

## Preface

I am indebted to many people who contributed invaluable suggestions, many of which were incorporated into the final system. Specifically thanks go to Mr. Hans Laping for engineering assistance, particularly in the radio frequency spectrum; to SSgt Robert Dumont who supplied a technician's point of view thereby permitting operational stumbling blocks to be eliminated; to Capt Peter L. Miller who wrote the complete programs for the dictionaries, to Mr. Charles Mitropoulos who designed the SAVE-3; to Mr. Alan Griffin who designed the automatic ground station; and to Mrs. Carol McMahon and Ms Margo Cross who typed the original drafts of this report.

## Contents

1. INTRODUCTION	11
1.1 History	11
1.2 Theoretical Flight System	12
1.2.1 Instrumentation	12
1.2.2 Energy Storage	13
1.2.3 Control Devices	13
1.3 Samplers and Sensors	13
1.3.1 Samplers	13
1.3.2 Sensors	13
1.4 Original System	13
1.5 Design Constraints	14
2. SYSTEM DEVELOPMENT	14
2.1 Year 1972	14
2.1.1 Control Changes	15
2.1.2 Command Receiver Change	15
2.1.3 Transmitter Change	16
2.1.4 Data System Change	16
2.1.5 Flight (Test) No. 1: Mission H72-72/H14X	16
2.1.6 In-Use Equipment	18
2.2 Year 1973	18
2.2.1 Control Changes	18
2.2.2 Transmitter Changes	20
2.2.3 Data System Changes	20
2.2.4 The Ground Station	22
2.2.5 Flight (Test) Nos. 2, 3, and 4	23
2.2.6 In-Use Equipment	23
2.2.7 Instrumentation Comparison by Weight	24
2.3 Year 1974	25
2.3.1 Control Changes	29
2.3.2 Data System Changes	30
2.3.3 Transmitter Section Changes	32
2.3.4 Test Flights	32

## Contents

2.3.4.1	Flight (Test) Nos. 5, 6, and 7; June	33
2.3.4.2	Flight (Test) Nos. 8, 9, and 10; October/November	35
2.3.4.3	Flight (Test) Nos. 11 and 12; December	37
2.3.5	In-Use Equipment	39
2.4	Year 1975	39
2.4.1	Control Change	39
2.4.2	Data System Change	41
2.4.3	The Ground Station	41
2.4.4	Test Equipment	42
2.4.5	Sampling Equipment Acronyms	43
2.4.6	Operational Flights	44
2.4.6.1	Tests 13 and 14; April	44
2.4.6.2	Tests 15, 16, and 17; July	44
2.4.6.3	Tests 18 and 19; October	45
2.4.6.4	Tests 20 and 21; December	50
2.4.7	In-Use Equipment	52
2.5	Year 1976	53
2.5.1	Control Changes	53
2.5.2	Data System Changes	54
2.5.3	Sensors	55
2.5.4	Operational Flights	55
2.5.4.1	Test 22; April	55
2.5.4.2	Tests 23 and 24; November	56
2.5.5	Comments	57
2.5.6	In-Use Equipment	57
3.	COMMENTS AND CONCLUSIONS	58
3.1	Objectives	58
3.2	Documentation	58
3.3	Functional Verification	58
3.4	Additional Flights	58
	REFERENCES	61
APPENDIX A:	Tabulation of Flight Equipment Usage	63
APPENDIX B:	Flight System Configurations	65
APPENDIX C:	Information to Support Direct Flow Samplers	75
APPENDIX D:	Progress Report: 18 July 1973	79
APPENDIX E:	Instrumentation Checklist	89
APPENDIX F:	Flow Rate Program	119
APPENDIX G:	Temperature Program	143
APPENDIX H:	Primary Altitude Program	171
APPENDIX I:	Backup Altitude Program	201
APPENDIX J:	Environmental Chamber Tests of PR-3 Flow Rate Sensors	237
APPENDIX K:	Electrical Detonation of Primary and Secondary Separation Squibs	241

## Illustrations

1. Theoretical Flight System	12
2. Flight Package, H72-73	17
3. Basic High Current Switch Schematic	19
4. Flow Sensors, H73-50/H-28X	22
5. Ground Station Configurations	23
6. Flight Package, H72-27/H-41X	26
7. Primary Instrumentation	27
8. Primary Instrumentation Layout	28
9. Primary Controller	29
10. Backup Controller	30
11. Data Printer	30
12. Tenney Release Devices - Original Configuration	40
13. Tenney Release Devices - Present Configuration	40
14. Ground Station: Present Configuration	41
15. Ground Station (Less Receiver)	42
16. Isolation Strap at Bottom End Fitting	47
17. Typical Relay Driver Protection	49
18. RFI Filter: Ferrite Beads	52
19. Burst Pin Assembly on Parachute	54
20. Gondola: SAVE-3	56
B1. Original System Configuration	66
B2. Flight (Test) No. 1 Configuration	67
B3. Flight (Test) No. 2 Configuration	68
B4. Flight (Test) No. 3 Configuration	69
B5. Flight (Test) No. 4 Configuration	70
B6. Flight (Test) Nos. 5, 6, and 7 Configurations	71
B7. Flights 8 through 21 Configuration	72
B8. Flights 22, 23, and 24 Configurations	73
C1. DFS Current vs Voltage and Altitude	77
C2. BB405 Hours and Ampere-Hours vs Current	78
J1. Typical Flow Rate Sensor Monitoring Circuit	239
K1. Model of Primary and Secondary Release Devices	243

## Tables

1. Comparison of Primary Instrumentation Weights Without Cables	25
2. Theoretical Encoder Resolution	32
3. Flow Rate Sensor Data: Test 10	37
4. Flow Rate Sensor Data: Test 11	38
5. Flow Rate Sensor Data: Test 12	38
6. Instrumentation Configurations	43
A1. SCADS-2 Flights	64
C1. Average DFS Current vs Voltage	76
J1. Flow Rate Errors	238
J2. Test Results	240

## About the Development of a Second Generation Atmospheric Sampler Control and Data System: SCADS-2

### 1. INTRODUCTION

#### 1.1 History

Air Force Cambridge Research Laboratories, (AFCRL) investigates the interface between geophysical science and Air Force operational requirements. Some upper atmosphere experiments are conducted via balloon-borne platforms. In 1971, AFCRL assumed operational responsibility from the Military Airlift Command (MAC) for the atmospheric sampling program, Project Ash Can. Equipment used in routine sampling missions was transferred from Detachment 31, 6th Weather Wing (MAC) to Detachment 1, AFCRL (AFSC) at Holloman AFB, New Mexico. The equipment was functional, and since key personnel transferred to Det 1, operations continued with an acceptable success rate. However, because project equipment had been designed or fabricated in the 1950's time frame, the funding agency, the Atomic Energy Commission (AEC) and its technical advisor organization, the National Oceanic and Atmospheric Administration (NOAA), requested that AFCRL design a second generation instrumentation system using the existing samplers and sensors.<sup>1</sup>

---

(Received for publication 14 March 1978)

1. Cordella, R.H., Jr., Capt (1974) A control and telemetry system for a balloon-borne air sampling package, Proceedings, Eighth AFCRL Scientific Balloon Symposium, 30 September to 3 October 1974, AFCRL-TR-74-0393, pp 451-476.

## 1.2 Theoretical Flight System

The system is depicted in Figure 1. This model benefits from insight gained during system development and includes desirable features not obvious from the beginning. It is a good starting place because it does apply to the original system and all developmental stages.

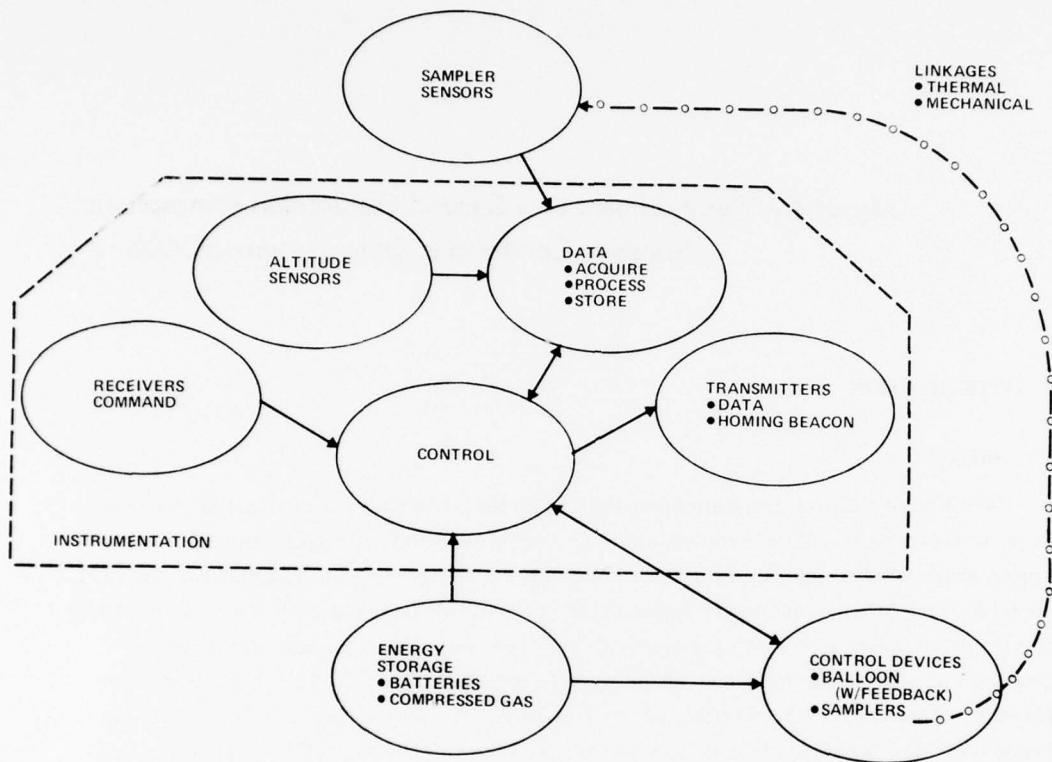


Figure 1. Theoretical Flight System

### 1.2.1 INSTRUMENTATION

The flight instrumentation is easily segmented into five subsystems associated with control, radio commands, altitude sensors, data, recorders, and transmitters. All controlling functions for the balloon and samplers either originate in the controller from internal time and altitude references, or pass through the controller if originated by a radio command. Some control functions are duplicated to provide flight safety. The command receivers are devices which, upon receipt of the proper

coded radio signal issued from the ground station, generate switch closures that force certain events to occur. Altitude sensors are electro-mechanical pressure sensors that are calibrated for altitude vs standard atmospheric pressure. They generate electrical signals which are transmitted to the ground station and provide information needed for flight control. The data subsystem acquires signals from the sensors, and processes them for recording and transmission. The transmitter radiates UHF or HF energy to move the various data to the ground station; the homing beacon provides a means to help an aircraft locate the instrumentation package.

#### 1.2.2 ENERGY STORAGE

Batteries and compressed nitrogen serve as energy reservoirs for the instruments and samplers.

#### 1.2.3 CONTROL DEVICES

Various devices must be activated to achieve mission objectives, that is, obtain samples and the required support data. These devices include: a helium gas release valve, a ballast valve, and electromechanical devices to activate and deactivate samplers. At the end of a mission, several operations are accomplished in sequence to terminate the flight and to secure the system when it impacts the ground.

### 1.3 Samplers and Sensors

These devices are the prime movers for the mission. Atmospheric constituents are gathered by various mechanisms; temperatures and flow rates are measured to compute the volume of air from which each sample was obtained.

#### 1.3.1 SAMPLERS

The principal samplers are the air ejector sampler (AE), the Carbon-14 Sampler (C-14), and the Direct Flow Sampler (DFS). The first two are driven by nitrogen aspirators, the latter by a fan coupled to a d-c motor.

#### 1.3.2 SENSORS

Altitude data are derived from primary and backup pressure sensors. Flow rate and temperature data are derived from PR-3 Flowmeter Sensors.

### 1.4 Original System

This system consists of two subsystems called "Primary" and "Backup" (see Figure B1). However, these terms are misleading because both systems had to operate properly to complete a routine mission. Primary instrumentation functions

are dropping ballast, energizing and deenergizing samplers, deploying the transmitting antenna, and terminating the balloon flight. Backup instrumentation functions are latching open the gas valve, cycling the gas valve, and terminating the mission. Note that only the termination function has redundancy. Timed functions are derived from a d-c chronometric motor driving a gear train. All logical functions are performed by relays and diodes.

### 1.5 Design Constraints

Succinctly stated, the set of functions accomplished by the second generation equipment had to include all those provided by the first generation equipment, but the new system had to do them more accurately while using less power and having less weight. (In fact, other functions were added to improve the system.)

## 2. SYSTEM DEVELOPMENT

The original (1972) concept of instrumentation modernization was to introduce new equipment in three steps: Replace first, the control equipment, second, the data acquisition equipment, and finally, the equipment for backup control. The data processing ground station would be expanded and automated after the new balloon-borne data system was functional. The program began as described but was re-directed because of manpower and operational constraints.\*

Previewing the development period in very general terms by year shows that the latter part of 1972 and all 1973 were dedicated to implementing the new system concept in hardware. Year 1974 was spent refining the hardware and introducing software, checklists, and computer programs. Operational flight testing and software updating occupied 1975. Hardware, software, and documentation were finalized in 1976.

### 2.1 Year 1972

Initially, documentation for the existing system was reviewed. An overall system diagram was produced from drawings of individual cables and equipment. Subsequently, a prototype replacement controller was designed and fabricated.

---

\* This report will discuss the developments in chronological order except in instances where describing the final resolution of the topic will result in a much clearer presentation. Also, significant changes necessary to maintain operational integrity of the original system will be documented in chronological order.

### 2.1.1 CONTROL CHANGES

Primarily, changes took place in two areas; control and control devices. The original "control unit" was replaced with a "controller" designed around digital logic; some redundancy in balloon control was added by modifying the original "backup timer" to facilitate redundant control at the lifting gas valve. A device which became known as the high current switch (HCS) was added to the control devices. This enabled the high motor current required by the Direct Flow Sampler (DFS) to be rerouted, thereby by-passing the control section. (At float altitude the current is between 10 and 27 A, a function of altitude and battery voltage; see Appendix C. The sampler starting current surge is about 100 A).

Comparing Figure B1, Original System Configuration, and Figure B2, Flight Test No. 1 Configuration, will help understand the changes. Two sub-systems which had been necessary for every flight were now joined to enable redundant gas-valve control. To accomplish this, a modification was added to the backup timer, but the basic timer remained an electro-mechanical device as was the control unit. Notice also that the original system dropped slugs (25 lb each) of ballast while the first reconfiguration (Figure B2) used a ballast hopper to permit either incremental pouring of ballast or dropping the entire 300-lb maximum load.

As in the original system, the controller remained the power distribution point for all primary instrumentation. Fuses were added to protect the system if a piece of support equipment should fail in a low resistance mode.

### 2.1.2 COMMAND RECEIVER CHANGE

Requirements for increased control capability necessitated expanding the command lines from the receiver. The original Raven command receiver/decoder<sup>2</sup> had six command channels (lines) of which five were used for antenna deploy, drop ballast, samplers on, samplers off, and primary flight termination (see Figure B1). Seven command lines are needed for the controller to execute those five plus two additional functions; pour ballast, and valve failsafe (see Figure B2). The Raven six-command receiver/decoder was replaced with a Zenith receiver and decoder which provided nine commands.<sup>3,4</sup> On Figure B2 and others where the Zenith

2. Instruction Book: Command Receiver/Decoder, Raven Industries, Inc., Box 1007, Sioux Falls, South Dakota 57101.
3. Handbook of Instructions for Dual Frequency Command Receiver BCR-4B, Developed for Air Force Cambridge Research Center, Air Research and Development Command, Bedford, MA 01731, under Contract No. F19650-67-0053, 15 March 1967. Manufactured by Military Division, Zenith Radio Corporation, 6501 West Grand Avenue, Chicago, Illinois 60635.
4. Final Engineering Report on Command Selector BCS-2A-3818, Prepared for Electronics Systems Division, AFCRL(AFSC), Laurence G. Hanscom Field, Bedford, MA under Contract No. AF19(628)-3818, 12 December 1964, Government and Special Products Division, Zenith Radio Corporation, 6501 West Grand Avenue, Chicago, Illinois 60635.

receiving equipment is shown with "tone reeds", these external reeds replace older, less reliable reeds that were located in the Zenith command decoder. Also, the Zenith Command receiver system has a feature which the Raven equipment does not possess; that is, prior to a command's being executed a reply code is generated which identifies the command channel selected for use. This code is transmitted to the ground station operator enabling him to verify the selection prior to command execution.

The Zenith receiver used with the backup system is slightly different than that used in the primary system. It has a single frequency front end, and, because it is not used with a command decoder, only three commands are available.<sup>5</sup> These commands do not have the reply confirmation feature because that capability is normally incorporated in the command selector.

#### 2.1.3 TRANSMITTER CHANGE

A Zenith HF transmitter was added to the system to transmit the reply codes.<sup>6</sup> Litton's FM transmitter is modulated directly by the sensor outputs which are analog, audio range signals.<sup>7</sup>

#### 2.1.4 DATA SYSTEM CHANGE

Figure B1 shows that in the original system configuration, data signals from the PR-3 Flowmeter System<sup>8</sup> and the B-60<sup>9</sup> altitude sensor went directly from the sensors to the FM transmitter. When the Zenith transmitter was added to accommodate the command replies, data from the B-34 altitude sensor,<sup>10</sup> which also generates a code in the form of ground closures, was routed through the controller to the Zenith transmitter.

#### 2.1.5 FLIGHT (TEST) NO. 1, MISSION H72-72/H14X

With the modifications described in the preceeding four paragraphs accomplished, a test flight was launched on 2 November 1972 from the operation test site at Holloman AFB, New Mexico. Figure 2 shows the sampling package prior to launch. The center equipment is a direct flow sampler (DFS) with a PR-3 flow sensor protected by a cage. Air enters at the bottom and is exhausted at the right side, through the PR-3 flow sensor output. The High Current Switch is mounted on the DFS above the flow sensor. The two insulated thermal packages to the left contain the batteries (bottom box) and the backup system (upper box); the thermal package on the right contains the primary instrumentation. Located between the instrumentation and the batteries is the ballast hopper, behind which is another direct flow sampler.

---

(Because of the large number of references cited above, they will not be listed here. See Reference Page 61 for References 5 through 11.)

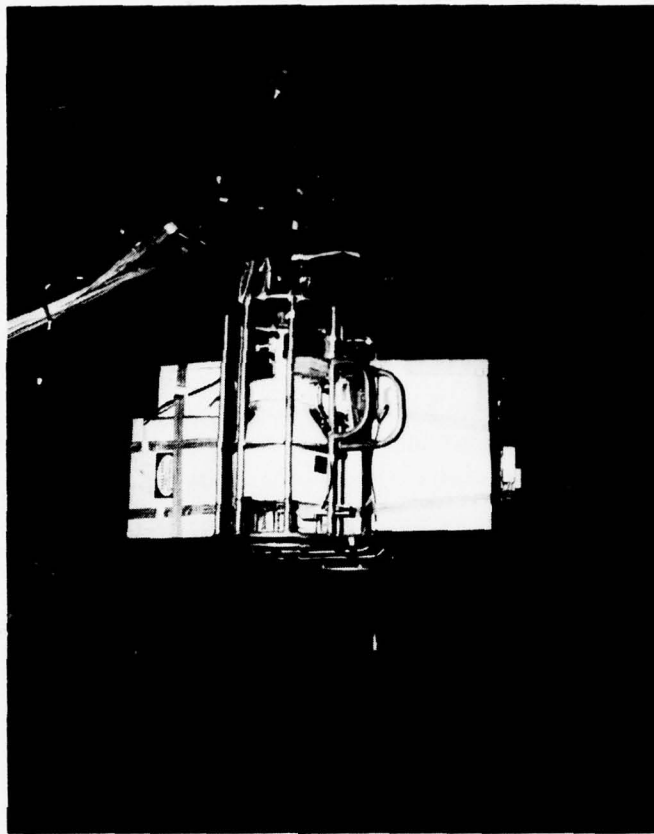


Figure 2. Flight Package, H72-73

Appendix A contains a complete list of the flights and the equipment used on each. The projected float altitude of 21.3 km (70 kft) was not reached because the flight was terminated on ascent at 14.3 km (47 kft). Although certain transmitted signals indicated termination due to balloon trouble, examination of the balloon revealed that certain processes had occurred which take place during a normal termination, and not usually during a balloon burst. Also, the prototype controller (sn 01) functioned correctly during post-flight tests so that a control malfunction could not be proven. However, reviewing the facts and schematics from today's vantage point indicated that the premature flight ending may have been caused by radio frequency interferences from the Litton data transmitter. This will be discussed at a later point.

As a test of the instrumentation, the flight was not a loss, because several important points surfaced. First, the initial High Current Switch, a mechanically latching relay, latched on at impact when the parachute returned the system to earth. No damage was done, but if the flight had been successful to that point, the sample would have been contaminated. Therefore, the relay was replaced with a solid state switch which will be discussed in Section 2.2.1. Second, personnel at the Balloon Operations Test Branch suggested that the controller be designed to de-energize the samplers at flight termination, before the ballast remaining on board is jettisoned, and to logically inhibit the reactivation of the samplers. Both of these suggestions have since been incorporated into the system instrumentation.

#### 2.1.6 IN-USE EQUIPMENT

Since AFGL was responsible for the operational flights, it was deemed necessary to have a relatively complete set of balloon-borne and ground equipment at the laboratory in a configuration similar to that used in the field. Therefore, a portable cabinet was procured and fitted with equipment to duplicate the operational ground station.

### 2.2 Year 1973

Data acquisition enhancement was stressed during this period and with the exception of the flight-data recorder, prototypes of each piece of new equipment that were to be used in the follow-on system were flight tested. Accomplishments in the major system categories will be discussed below, and actions resulting from knowledge gained from one or more of the flight tests of March, July, and October will be noted.

A letter report was written in July to inform the AEC of the project's status, plans, and options. Parts of this report are included as Appendix D. Figures B2 through B5 cover test flight block diagrams. Detailed explanations of the encoder operation and control theory are included in Appendix D along with a comparison of the in-use and developmental system capabilities.

#### 2.2.1 CONTROL CHANGES

Three major changes were made in the control system. As mentioned in Section 2.1.5, the first high current switch (HCS) was replaced by a solid state design using a silicon controlled rectifier (SCR). The first model was built around a "DC Static Switch" by General Electric Co.<sup>11</sup> Although it worked in the laboratory it failed to turn off reliably under simulated flight conditions; prior to the March flight it was modified. The modified switch configuration was subsequently abandoned

11. G. E. Silicon Controlled Rectifier Manual, edited by F. W. Gutzwiller, prepared for General Electric Company, 3800 North Milwaukee Avenue, Chicago, Illinois 60641, 1967, pp 153-155.

after the July flight, and the switch was reconfigured around the basic circuit shown with solid lines in Figure 3. (Circuit components such as those for gate protection and connectors are omitted for clarity.) The SCR turns the blower motor on, and the relay turns the motor off by interrupting the current, thereby allowing the SCR to turn off when sufficient time has elapsed to let the junction cool. This application of the relay was deemed acceptable based on information available in Reference 12 and discussions with an applications engineer. (Initially this circuit also included another SCR and a 1- $\Omega$  series resistor as shown in Figure 3). Terminal ON-1 was pulsed first, then 2 sec later, ON-2 was pulsed. Subsequently, in this way the startup current was limited to about 25 amperes. Calculations showed that the SCR (Motorola type MCR 3935-2) and the relay were capable of sustaining the initial surge current; the components shown by dashed lines were eliminated.

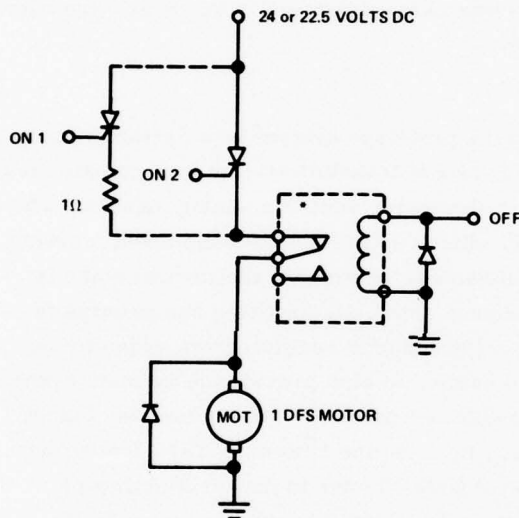


Figure 3. Basic High Current Switch Schematic

\*TEN AMPERE RELAY WITH TWO SETS IN PARALLEL

The second control change was the inclusion of "impact" switches located on the bottom of the payload system, and having the arming circuit located in the primary controller. This subsystem releases the parachute from the payload upon ground impact. The standard configuration was to fly an in-line switch between the payload and the parachute (see Figure 2). This type of switch depended upon

12. H-G Relay Engineering Manual, Document No. REM-1164, by Hi-G Incorporated, Windsor Locks, CO.06096, 1964, pp 6, 7, and 11.

the tension in the parachute line relaxing before half of the parachute risers could be released. Therefore, in windy conditions, when the circuit action is most needed, the switch is most likely to fail. The replacement impact switch circuit depends only upon momentary pressure at impact to complete a circuit which causes the parachute to be released. This circuit is armed only if the system passes both up and down through a pre-set altitude [usually 3 km (10,000 ft)]. This circuit has functioned properly on each flight since it was included in the system.

The third change was a mechanical reconfiguration of the controller. Serial No. 01 was difficult to work on because of its mechanical makeup. Also, it had several large relays on circuit boards designed to be fabricated in a printed wire mode. Serial No. 02, which was used for the three 1973 flights, had all circuitry on the case "cover." Therefore, when the unit was opened, the chassis and associated wiring were removed from the case. Two circuit boards held the logic and miniature interface relays (TO-5 type enclosure) while the larger relays were mounted on the chassis. This technique was carried through to the final controller configuration (Serial Nos. 03 and above).

#### 2.2.2 TRANSMITTER CHANGES

When the data encoder was added to the prototype system (see Section 2.2.3) it eliminated the need for the Litton SS/T-14 FM transmitter, the four commutated inputs of which were tailored to the PR-3 flowmeter sensor's analog signals. The encoder's output was a closure to ground which, as previously mentioned, worked well with the Zenith Command reply transmitter. However, the natural noise immunity of an FM signal would greatly enhance automatic decoding and printing of data by the ground station. Therefore, a 700-Hz tone oscillator was added to the controller (where it could be interrupted easily, to also provide the indication when radio commands were received) and provisions were made for the encoder output to pulse the tone into an FM transmitter. Because the Litton SS/T-14 data transmitters were nearing the end of their servicable life due to non-availability of replacement parts, a follow-on transmitter, the FMT-1A, was procured from Viable Systems, Inc. The FM transmitter used on Flight (Test) Nos. 3 and 4 was the Viable prototype; the FMT-1.<sup>13</sup>

#### 2.2.3 DATA SYSTEM CHANGES

Flight (Test) No. 1 (Section 2.1.5) in 1972 used basically the original data system. Flights in 1973 introduced and proved the data encoder. Built around a frequency-sensitive analog-to-digital converter, the encoder presented the data words as a serial bit stream which corresponds to Morse Code characters. The eleven data

---

13. Instruction Manual for Model FMT-1A FM Transmitter, AFCRL Contract No. F19650-74-C-0407, May 1974, Viable Systems, Incorporated, 299 Second Avenue, Needham Heights, MA 02194.

channels, which were buffered for specific inputs, included two for the B-60 altitude sensor (one for high altitude, one for low altitude); one for monitoring housekeeping functions—valve, ballast, burst switch status; and eight for monitoring four PR-3 flow sensors (flow rate and temperature). The three developmental flights described in the following paragraphs used the above encoder format (see Figures B3, B4, and B5) for flight configurations.

The encoder on Flight (Test) No. 2 monitored one PR-3 flow sensor flow rate, and two backup altitude sensors with voltage outputs. The voltages were converted to variable frequencies before they were routed into two unused flow sensor channels. These sensors provided data at altitudes from ground to float and were justification for discarding the original altitude sensor/transmitter (B-34). Sensor temperature was not monitored by the encoder but was recorded by the PR-3 flowmeter system as usual. The physical flight configuration was virtually identical to the first flight (see Figure 2). Unfortunately, a battery problem precluded gathering any flow data but the remainder of the system worked properly.

Flight (Test) No. 3 was very similar to No. 2 except that the flow sensor temperature was monitored by the encoder. Also, a PR-3 system was flown in a electrically independent mode to monitor the same outlet port as the PR-3 sensor monitored by the encoder. The volume of air passing through both of these two serially connected sensors (see Figure 4) was calculated independently. The two calculations agreed within 2.6 percent; well within the accuracy of the systems.

Flight (Test) No. 4 (H73-73/H32) was a milestone in this system's development. Because of the success of the previous flight and the attractiveness of saving operational funds, this test was combined with an operational flight requiring two direct flow samplers (DFS) and two Carbon 14 samplers. The two DFS's required three PR-3 flow sensors (two on outlets and one on an inlet); the C-14's required one sensor each. Since encoder sn01 could accommodate four PR-3 sensors and five were required, one was monitored by the standard PR-3 electronics/recorder. This flight configuration necessitated eliminating the back-up altitude sensors; and, since only the sensor part of the PR-3 system was used in five of the flow measurements, onboard recording was virtually eliminated. All flight data were acceptable; this was the prototype system's first success.

This flight configuration was consistent with the instrumentation configuration planned by AFGL, that is, the backup altitude sensors were to be eliminated and a digital recorder was to be added when it was available. However, the AEC advised us that redundant altitude data was mandatory at least at float altitude. Therefore, a backup altitude sensor was subsequently reinstated.

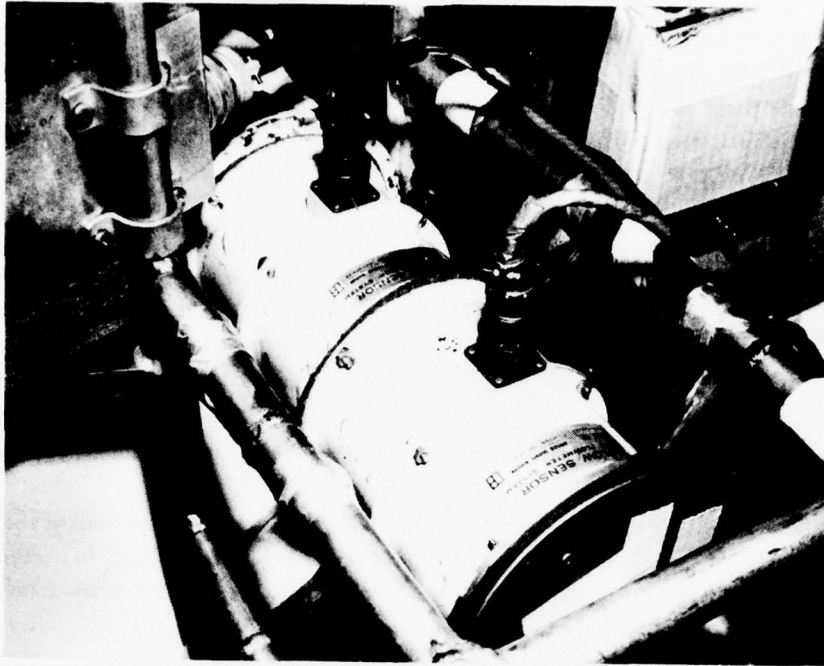


Figure 4. Flow Sensors, H73-50/H-28X

#### 2.2.4 THE GROUND STATION

Originally, at the ground station in the control center, analog signals were retrieved by an analog method and the results were logged by hand. As shown in Figure 5a, the receiver's audio output signal was routed to two areas for processing of two data types; altitude and flow rate. The altitude channel was monitored by a counter through a Schmitt trigger which detected the envelope of a pulsed 3000 Hz signal generated in the B-60 altitude sensor reference. Flow rate data was displayed as a Lissajous figure on an oscilloscope using frequency from an audio oscillator; the frequency which stabilized the Lissajous "circle" was recorded. This method kept the operator rather busy.

The developmental system transmitted digital words which were to be recorded (printed) automatically by the ground station; a forerunner of the automatic ground station was employed with the introduction of the Viable transmitter (see Figure 5b). The receiver 700-Hz audio tone was applied to a phase locked loop filter which reclaimed the dot or dash from the signal envelope. This serial message was recorded by a strip chart recorder providing a permanent record of the flight; reply

codes from the Zenith transmitters were also recorded. This method of obtaining a hard copy of the data was used until the middle of 1975 when the automatic printing ground station was introduced.

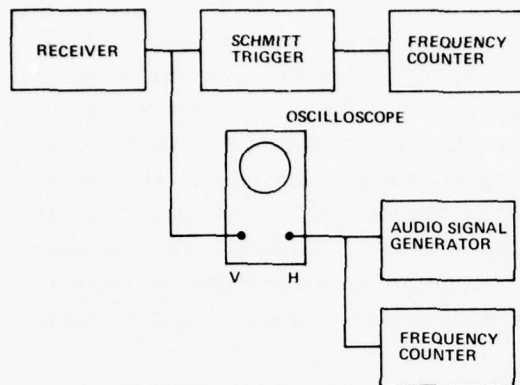
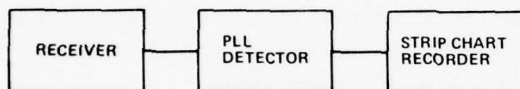


Figure 5. Ground Station Configuration

a) ORIGINAL CONFIGURATION



b) INTERIM CONFIGURATION

#### 2.2.5 FLIGHT (TEST) NOS. 2, 3, and 4

Flight No. H73-19/H19, the second test, successfully demonstrated the altitude monitoring capability of the encoder but, because of a bad battery, failed to monitor flow rate when the DFS did not operate properly. The controller performed properly.

The third test, H73-50/H28X, gathered a sample and support data and performed the volume checking experiment described earlier. However, after the sample period was over and the samplers were de-energized, the emergency sampler deactivation circuit failed a test and the sample was contaminated.

Test flight, H73-73/H-32, the fourth test, was successful in gathering a sampler and support data but the samplers de-energized prematurely when a cable carrying current to the DFS's failed. Luckily, the sample was just within the minimum collection time. A spinoff from this accident was a reconfigured battery container providing rigidity to protect the batteries, ample room for air circulation, and a connector so cables would not have to be attached directly to the battery terminals.

#### 2.2.6 IN-USE EQUIPMENT

During the early part of the year, time was spent researching possible sources for an altitude sensor equal to or exceeding the B-60 in range and accuracy. A

proposal by L'Garde, Inc. of Newport Beach, California, initially appeared interesting. Their theoretical sensor used an isotope of americium with a silicon detector but, after detailed calculations by the vendor, the specifications were modified out of our range of interest. A satisfactory replacement was not located but the need was kept in mind as technical literature was read (see Reference 19).

An endeavor begun that year, which was rapidly to bear fruit, was the design and fabrication of a new gondola for the sampling equipment. The author and Mr. Charles Mitropoulos, a mechanical-engineer from AFGL/SU, assembled specifications and Mr. Mitropoulos designed a gondola to accommodate the samplers, instrumentation, battery boxes, ballast hoppers, and gas containers. After several stages of redesign, a dozen gondolas (dubbed the SAVE-3, for SAMpling VEHICLE) were procured through the facilities of NOAA in 1976. These gondolas are now used with the original system as well as the follow-on instrumentation systems because they are much more efficient than the original system for assembling a flight system.

As noted earlier, the SS/T-14 FM transmitters were at the end of their economically useful lives. Therefore, replacements were sought and later procured from Viable Systems, Inc. To use the transmitter with both systems, the commutating capability of the T-14 was duplicated in a separate unit (signal conditioner, SC-2) that was supplied by Viable with the transmitters.

#### 2.2.7 INSTRUMENTATION COMPARISON BY WEIGHT

Since every pound of equipment must be buoyed by the helium in the balloon, extra weight is rapidly converted into dollars for larger balloons. Also, interest in atmospheric sampling was increasing and any weight saved could be applied to other experiments as well. Table 1 lists equipment weights and shows in the totals that the new instrumentation was lighter than the in-use instrumentation. The weight advantage grows with the make of PR-3 sensors required because only the sensor is added to the system, whereas the existing system needed an additional recorder/electronics package for each additive PR-3. Therefore, the weight design criteria of Section 1.5 has been met.

Table 1. Comparison of Primary Instrumentation Weights  
Without Cables\*

Item	Weight (lb)	
	In-Use System	Proposed system
Thermal Bag	6	
Shock Absorbent	5	
Frame, Instrumentation		7.5
Thermal Box		10.2
Control Unit	9	7.0
Receiving System	6	6.0
Transmitter: T-14	5	---
FMT-1	-	2.0 (max)
B-60	2.7	2.7
B-34	4.0	---
Rosemount & Converter	---	1.5
Encoder	---	2.6
PR-3 Recorder (No. 1)	9.0	---
Data Printer	---	2.0 (max)
PR-3 Sensor (No. 1)	2.0	2.0
Subtotal	48.7	43.5
PR-3 System (No. 2)	59.7	45.5
PR-3 System (No. 3)	70.7	47.5
PR-3 System (No. 4)	81.7	49.5
PR-3 System (No. 5)	92.7	51.5
PR-3 System (No. 6)	103.7	53.5

\* In-use system cables weigh more than proposed system cables.

### 2.3 Year 1974

Tests in 1973 confirmed the model in Figure 1 (from which the final systems in Figures B6 through B8 were derived).

Commencing in 1974, SAVE-3 gondolas were used and evaluated. Figure 6 is a picture of the flight payload for H74-27/H-41X which used this gondola. A direct flow sampler, and a Carbon-14 sampler (at right) are mounted on the gondola exterior; the interior contains (starting at the top) primary instrumentation, batteries, backup instrumentation, and a ballast hopper. To the left of the ballast hopper (the inverted pyramid) is the antenna deploy device (parachute). Impact switches are on four corners of the shock-absorbing pad.

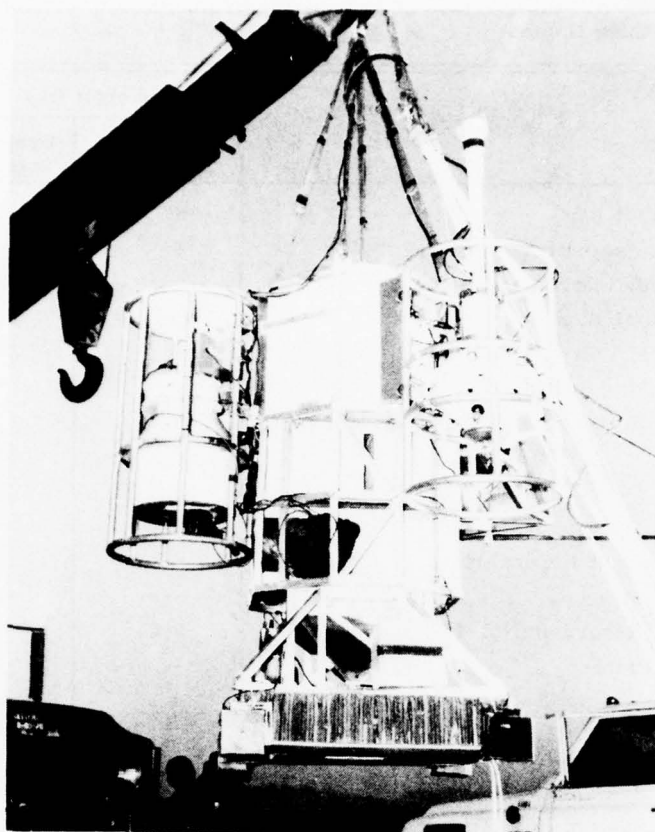


Figure 6. Flight Package, H74-27/H-41X

The primary instrumentation was repackaged to fit the SAVE-3 gondola. Originally in a  $58.4 \times 56.9 \times 35.6$  cm ( $23 \times 22 \times 14$  in.) frame carried outboard in a thermal insulation box with 2-in. walls, the new version used a  $41.9 \times 41.9 \times 39.4$  cm ( $16\frac{1}{2} \times 16\frac{1}{2} \times 15\frac{1}{2}$  in.) frame (see Figure 7) in a similar thermal insulation box which was set into the uppermost section of the gondola. When the PR-3 recorder units were discarded for the encoder and central data printer, a reduction in volume was accomplished.

The equipment placement in this primary instrumentation configuration was used for the three tests in July 1974. During that initial flight series for the SAVE-3, it was discovered that the connectors on the exterior of the primary instrumentation fell behind the gondola stanchions or samplers. Thereafter, a mirror-image instrumentation configuration was used which placed the connectors

at sections of the gondola which were always easily accessible. Figure 8b represents the final equipment layout.

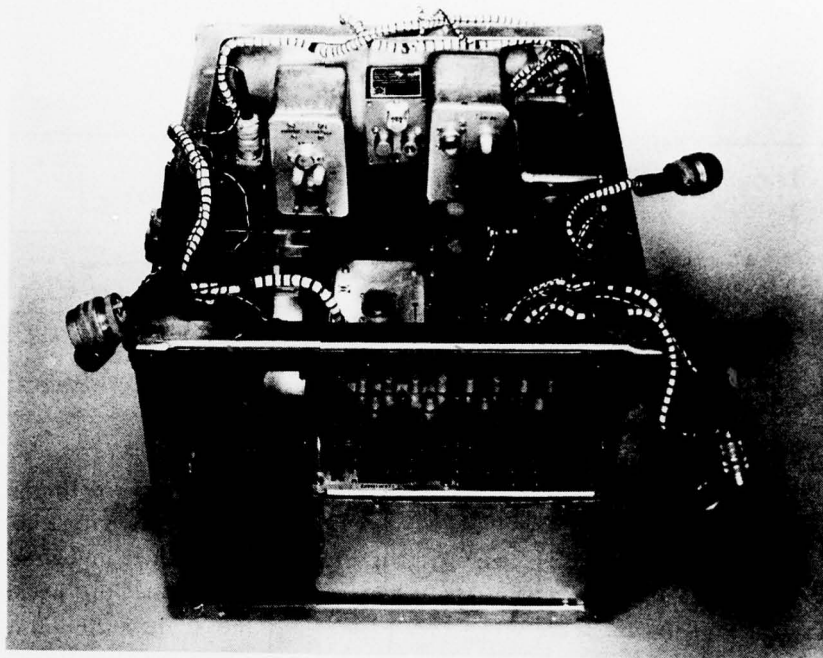


Figure 7. Primary Instrumentation

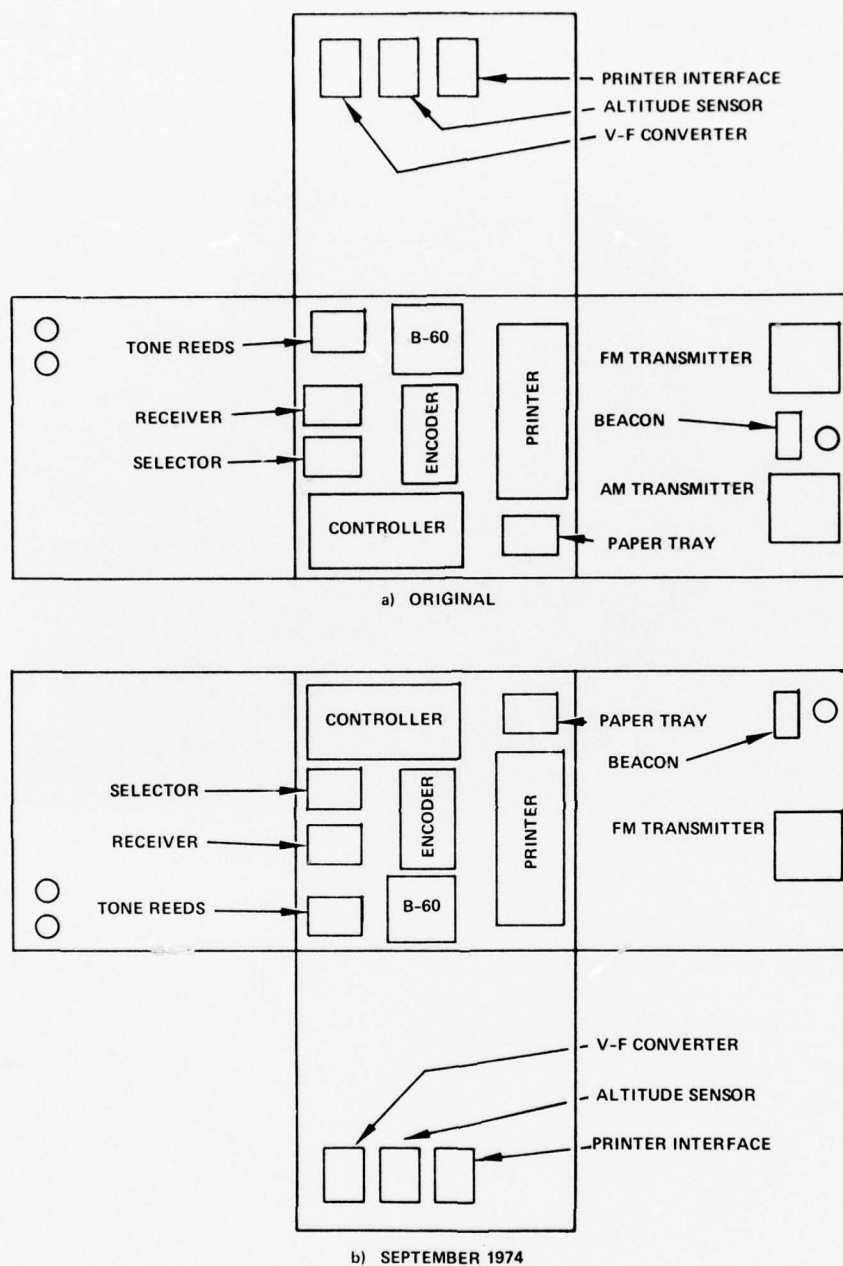


Figure 8. Primary Instrumentation Layout

### 2.3.1 CONTROL CHANGES

The primary controller was reconfigured into its present package and its connectors were reduced from six to five (see Figure 9). This change simplified construction and testing because the wires were grouped functionally. It also facilitated the implementation of a simple connector-numbering system. Each cable type was assigned a prefix number (0 through 10); 0, RFI filters; 1, primary system power; 2, command receiver; 3, control; 4, data; 5, data transmitter; 6, system interface; 7, backup instrumentation; 8, DFS, DFS cables; 9, DFS battery cable; 10, existing flight equipment. For example, the digit 4 represents data system connectors or cables in or on the primary frame, that is, J40 on the controller to J415; there are 16 connectors. See the project handbook<sup>14</sup> for drawings, parts numbers, etc.

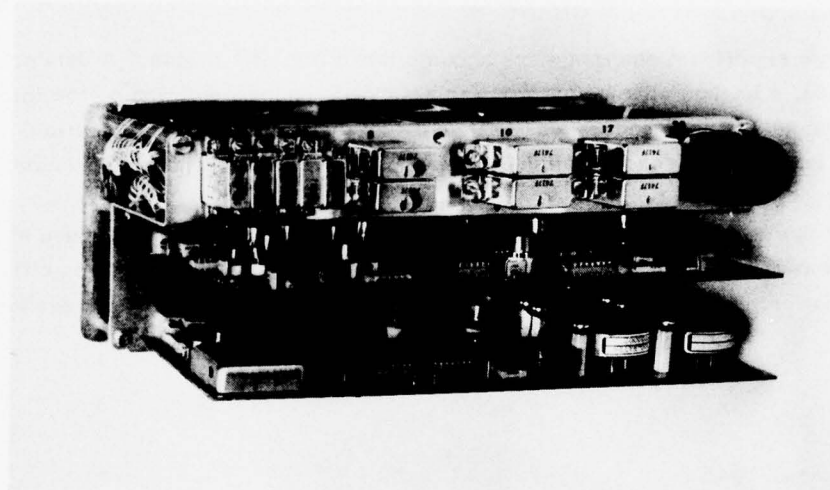


Figure 9. Primary Controller

In July the original backup control unit with gas valve modification was replaced with a solid state crystal clocked controller. Compare figures B6 and B7. Notice that the ballast hopper control functions are now redundant; and the gas valve latch-open function has been dropped because each controller does it automatically at termination. The three backup controller commands are ballast pour, gas valve failsafe, and termination (see Figure 10).

14. Cordella, R.H., Jr., Capt (1977) Project Ash Can Atmospheric Sampling Handbook, Volume II, Instrumentation: SCADS-2, AFGL, Aerospace Instrumentation Division, Hanscom AFB, MA 01731.

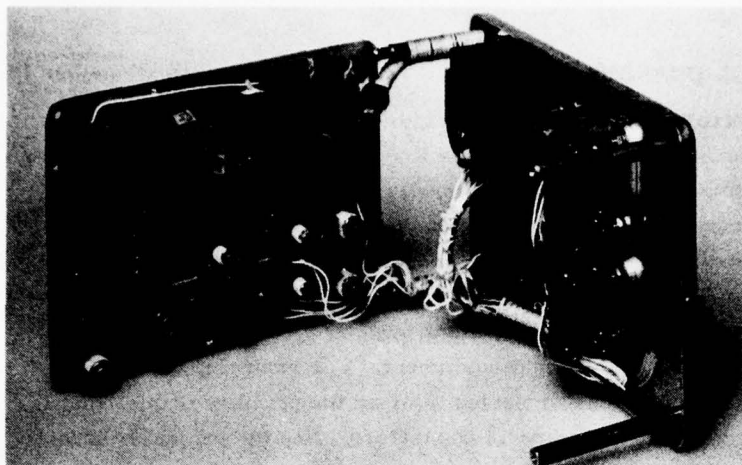


Figure 10.  
Backup Controller

### 2.3.2 DATA SYSTEM CHANGES

Three significant changes were accomplished for 1974 flights. A data printer was added, a backup altitude sensor was returned, and information on the initial three channels of the encoder was changed. To facilitate wiring and testing, the chassis cables were reaccomplished to reduce the external control connector count to one.

The printer (Figure 11) described in Reference 15 was chosen because at that time it was the only lightweight device, less than 746 g (2 lb) operable on either a-c or d-c power. This feature facilitated its use on both ground and flight systems.

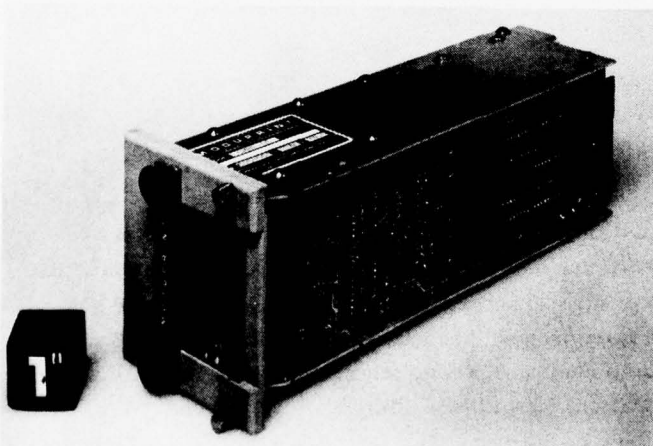


Figure 11. Data Printer

15. Instruction Manual: Model No. CMMP-6A, July 1973, Practical Automation Inc., Trapp Falls Road, Shelton, CO 06484.

The internal printer functions are accomplished by transistor-transistor logic (TTL); an interface provides the regulated voltage and buffers to change voltage levels (CMOS to TTL). At 3-min intervals, a time-code generator produces a 2-digit decimal number which is printed with every data word. This time count is derived from the controller signal which initiates the encoder message, and is referenced to the time when power was applied to the system prior to launch. All data produced by the encoder is hardcopy printed. The word format corresponds to that used by the ground station and the data backup dictionaries. (The dictionaries will be discussed at the end of this section.)

Provision of two methods of obtaining altitude data at the float altitude was a firm requirement. Accordingly, a channel was devoted to monitoring the backup sensor through a voltage-to-frequency converter (see Section 2.2.3). The decision was made to keep the encoder size constant by placing all B-60 altitude data on Channel 1 and maintain the 15 data channel format consistent with the available logic packages. Condensing the B-60 altitude sensor data on one channel necessitated rescaling the constant used in the signal multiplication.<sup>1</sup> Maximum altitude for routine flights was between 18.3 km and 27.4 km (60 to 90 kft) but a requirement exists to reach 36.6 km (120 kft), therefore, an option was included in the encoder to select one of two scaling frequencies based on the float altitude. As in all compromises, you never get something for nothing. Placing all the primary altitude data on one channel cost resolution at the lower altitudes.

Theoretical encoder primary altitude resolution (Table 2) is extracted from unpublished calculations of January 1978. Since the balloon ascends at about 305 m/sec (1 kft/min) this resolution is acceptable. The upper limit of the normal range is about 33 km (106 kft); the extended range is about 42 km (136 kft). This altitude will vary slightly between units because they are not identical.

The encoder format has been finalized as follows: Channel 1, B-60 sensor altitude; 2, housekeeping; 3, backup altitude; 4, 6, 8, 10, 12, 14 flow rate; 5, 7, 9, 11, 13, 15 temperature. The latter 12 channels (channels 4 through 15) are grouped in two's to accommodate six PR-3 flow sensors. A dictionary is used for all channels except channel 2, housekeeping, which has only four possible code options to indicate actuation of the gas valve, ballast hopper, or parachute open indicating switch. See Section 2.2.3.

Data words are based on a twelve bit binary counter; therefore, there are 4096 states or combinations which must be correlated to the actual parameters: flow rate, temperature, and altitude. Dictionaries produced on a CDC 6600 computer accomplish this correlation. These programs were produced in collaboration with Peter L. Miller, Capt, USAF. He wrote the programs after the author presented a rough outline of what they were to do and the sensor characteristics. The programs, their inputs, and their outputs are explained in Appendices F through I

Table 2. Theoretical Encoder Resolution

Altitude		Range	
kft	(km)	Normal	Extended
		Resolution:	ft (m)
10	(3.0)	184 (56)	588 (179)
20	(6.1)	260 (79)	833 (254)
30	(9.1)	260 (79)	833 (254)
40	(12.2)	216 (66)	689 (210)
50	(15.2)	170 (52)	543 (166)
60	(18.3)	125 (38)	403 (123)
70	(21.3)	91 (28)	292 (89)
80	(24.4)	64 (20)	207 (63)
90	(27.4)	45 (14)	145 (44)
100	(30.5)	31 (9)	101 (31)
110	(33.5)		75 (23)
120	(36.6)		54 (16)
130	(39.6)		40 (12)
140	(42.7)		31 (9)

### 2.3.3 TRANSMITTER SECTION CHANGES

The quality of the received signal from the 40 MHz transmitter had been marginal since the beginning of the equipment updating. Various components in the signal path were analyzed and the transmitting antenna was determined to have the wrong impedance. Although the radiating element was the proper length, the matching transformer and stub dimensions could not be verified. Therefore, the original antenna (designated by an S in the transmitter column of Appendix A) was replaced with a modified dipole (D1). When the FMT-1A transmitters were used, signal strength again became unacceptable so a second modified dipole was designed, tested, and implemented in October. This antenna was used for just over one year when it was replaced with a modified Zepp (Z) antenna<sup>16</sup> to facilitate automatic deployment. Mr. Hans Laping AFGL/LCC designed the Zepp antenna.

### 2.3.4 TEST FLIGHTS

The eight flight tests in 1974 will be grouped according to the time frame of the experiments for the following discussion. Appendix A lists the equipment for each flight.

16. The ARRL Antenna Book, published by the American Radio Relay League, Inc., Newington, CO, 1974, pp 108, 109, and 116.

#### 2.3.4.1 Tests 5, 6, and 7; June

On test 5, H74-27/H-41X, the HF antenna did not deploy because one squib in the antenna parachute failed to cut the nylon line. At 6.4 km (21 kft), with the balloon ascending at about 305 m (1000 ft) per min, the encoder readout was expanded from 3 to 15 channels. The encoder data format was correct but no temperature data were present on the appropriate odd numbered channels. One hr and 16 min into the flight the samplers were turned on by command and flow data commenced on the appropriate even numbered channels. The received signal was clear but the data were very noisy and within 21 min a high noise level obscured all data; the noise produced random counts on the temperature channels. This condition continued for approximately 1 hr at which time the samplers were commanded off; the noise then stopped. The samplers were restarted and the noise did not reappear. Late in the flight there were still no temperature data from the samplers; however, the thermistor located within the encoder did yield apparently valid data. After a 4-hr sample period, the samplers were turned off via command and the flight was then terminated. The termination, descent, and impact were all normal and there was little damage to the SAVE-2 gondola or the samplers.

The noise in the data was initially attributed to, first, the failure of the antenna to deploy from the chute causing a severe mismatch at the transmitter output section. The mismatch resulted in an abnormally high RF field in the vicinity of the instrument system that could easily couple into the system sensor input leads. The noise during the middle of the sample period was most likely due to brush arcing in the motor which was interrupted when the motor was shut off and then failed to return when the motor was restarted.

Although the sensor data was not of sufficient quality to merit processing, a usable sample was obtained and other capabilities of the new system were further tested. The High Current Switch was successfully cycled twice during the mission. The capability to turn the samplers off provides an important option if the balloon should move out of the sampling altitude envelope. The data were clearly received by the receiver and recorded on a strip chart by a phase lock loop (PLL) detector.

An effort was made to duplicate the noise problem on a tethered flight; H74-32. The prototype instrumentation was placed in a standard thermal package and set into the upper section of the flight gondola. The whole gondola and samplers were not flown because of weight restrictions and the necessity to keep the package several wave lengths away from the steel tethering cables. (These cables would have to be brought in closer to the package if a heavier weight were to be suspended.)

The balloon was positioned at an altitude of 600 ft; the instrumentation package was configured with the power and data cables flown on H74-27. The battery box was placed on top of the instrumentation package and DFS flow sensors were positioned

on the gondola to approximate their flight locations. The flight data cable was used. The HF antenna was placed on the gondola as low as possible on the same side it occupied during the free flight. The VHF-FM antenna was placed as it was on the free flight and remained that way throughout the test.

The system was tested in four modes: (1) both transmitters on, with the HF antenna rolled up and in the chute; (2) both transmitters on, and the HF antenna deployed; (3) the HF transmitter off and its antenna removed while the FM transmitter was on; and, (4) the data cable was changed from the flight cable to a cable of identical dimensions but using twisted pairs for each fan or thermistor with the FM transmitter energized. These four test configurations were observed over a period of about 2 hrs; data were recorded on a Gould chart recorder through a phase locked loop (PLL) detector. The data were excellent at all times. The malfunction which occurred during the flight could not be duplicated.

It was decided to re-fly a configuration similar to that of H74-27. Flight H74-36/H-42X had another DFS with another two PR-3 sensors and only the 40.35 MHz FM transmitter was used. The flight was successfully launched at 1346 Z hr after a flawless checkout and a short hold for surface winds. Altitude data from the B-60 were excellent. At about 14 km (46 kft) the Rosemount back-up altitude data began and was in excellent agreement with the B-50 sensor until the balloon rose out of the range of the back-up sensor. This flight was to 27.4 km (90 kft) and the sensor was chosen and calibrated for the previous flight which was only to 19.5 km (64 kft). At 1406 Z hr the balloon was at about 7.6 km (25 kft) and the encoder message was expanded to 15 channels. The data were excellent, giving a clear indication of the interior and exterior sampler and package temperatures. (The interior package temperature data corresponds very well with the data gathered on the latter portion of flight H74-27.) The gas valve was opened at 1458 Z hr for 4-1/2 min to slow the ascent rate and, although it is not recorded on the Encoder Log, the data was obscured by a steady tone for 63 seconds. This tone was recorded through the PLL onto a strip chart recorder and was discovered during the review of the flight records. It is the warning indication that the flight had been terminated by the burst-pin signal; however, the flight continued. Data were excellent but the samplers could not be started by timer or command. At termination, the package did not respond to the command via the primary system and the backup controller had to be used. The package was returned without power interruption, and the commands were "issued" using the command simulator and test box. The results duplicated the situation in flight; the samplers were unable to be activated, and command 9 (flight termination) was inoperative. Inspection revealed that the squib to release the Carbon-14 sampler gas was detonated as were the squibs for blow ballast. These events along with the 63-sec tone at 1458 Z hr indicated that a signal on the burst line had tried to terminate the flight. However, fuses for the

primary separation squib were blown and had prevented that squib from firing. It is believed that these fuses were not checked prior to launch, and had actually blown during the tethered test. The cause of the activation of the burst circuit was traced to a marginally protected logic gate input which connects directly to the burst switch. The activation of the valve motor caused an electromagnetic field in the parachute cable which coupled into this line and induced more than 100- $\mu$ A current necessary to trigger the logic. This circuit was desensitized to preclude a reoccurrence of this failure and similar gating equipment schematics were searched for similar oversights to prevent a related failure. This circuit was virtually identical to that used in Flight (Test) No. 1, Mission H72-73.

Besides uncovering a weak point in the hardware, the June flights pointed out the need for an extremely thorough checklist to assure the functional integrity of each unit before and after being integrated into the system. Appendix E is the latest Instrumentation Checklist. I use the term latest because the checklist is constantly evolving and adapting to the people who prepare the system for operational use. However, good testing practice is maintained throughout the sequence by beginning at the simplest level of each piece of equipment, setting the variables (usually times) as they are needed, and not disturbing the subsystem once they are checked.

#### 2.3.4.2 Tests 8, 9, and 10; October/November

Circuits were redesigned to preclude the reoccurrence of the problems encountered in June. A tethered balloon test preceded the next free flight to detect any flaw which had been overlooked. Test 8, Mission H74-55/H47X, placed the flight system in a good approximation of the electromagnetic environment it sees during a routine flight. The system consisted of the primary and back-up instrumentation and their batteries, the samplers and DFS batteries, a parachute cable, a simulated balloon cable, and an EV-13 gas valve. A standard 40.35 MHz antenna was used. This system was assembled in the gondola and suspended from a balloon tethered with non-conductive cables so the transmitting antenna was about 550 ft above the ground to approximate the free space radiation patterns. The pre-flight checklist for operational flights was used during this test.

A most significant piece of information was uncovered during this test. The wire which carries the signal from the burst monitor switch on the parachute is in series with a barometrically operated switch that closes at approximately 3 km (10 kft). Since the tethered system would remain below 1.5 km (5 kft) this switch was by-passed. The encoder and primary controller monitor the switch position and, when the order of applying power before closing the switch was exchanged, an erroneous interaction was noted. The erroneous interaction has been permanently removed by the addition of two steering diodes which permit current to flow only to ground through the burst pin switch and not between the two units. This test fulfilled

its objectives when it uncovered this circuit deficiency. It also demonstrated that radio commands could be utilized during a balloon flight without jeopardizing the sample collection mission, and it developed a data base for comparison of the transmitted and recorded data. In these data, the PR-3 flow sensor temperature was excellent but the flow rate was erratic. A second tethered mission was planned to further examine the system.

Test 9, H74-56/H-48X, equipment was configured as in Test 8. All data were recorded through the phase locked loop (PPL) tone detector and recorded on a strip chart recorder. The valve was cycled numerous times to insure that the current for the motor did not interfere with the burst pin switch circuitry as in flight H74-35/H-42X.

The data revealed that the flow rate sensor monitoring circuitry did not act properly. The complete primary instrumentation with the same data cable used in the flight was set up in the site laboratory and checked using the "Calibration Unit for PR-3 Flowmeter System" manufactured by (Litton) Applied Science.<sup>17</sup> The encoder circuit to eliminate the effect of the PR-3 relay contact bounce was inadequate; it was improved by changing the RC time constants while keeping the same circuit topology. (This check and subsequent correction was accomplished in the field because there were no "Calibration Units" at the headquarters in Massachusetts.)

Since the equipment performed satisfactorily on the two tethered tests and the flow rate monitoring circuit had been improved, a test under operational sampling conditions was in order. Test 10, mission H74-51/H-53X, was launched on 5 November. The equipment was that used on the tethered tests with the exception of the 40.35 MHz antenna which was a new quarter wave dipole. It is noted by D2 in the transmitter column of Appendix A. Changing from the standard antenna to this dipole marks the removal of the last piece of "standard" equipment; with one minor addition in 1976, the system was now SCADS-2.

Prelaunch checks were accomplished according to the Instrumentation Checklist. The actual launch was smooth and the flight continued uneventfully with all equipment functioning properly; the samplers were turned on and off by the system timer. After the data confirmed that all the samplers were off, the valve failsafe and pour ballast commands were issued and verified to confirm that these operations would not adversely affect the balloon flight through an unforeseen interaction. Shortly after these commands were completed, the flight was terminated by command on the primary instrumentation system.

The excellent quality of the recorded and transmitted data resulted in a sizeable data base to examine. Two aspects of the data were checked. First, accuracy;

---

17. Development and Calibration of the PR-3 Flowmeter, ASD Report No. 2723 by R.C. Wood, L.R. Graf, L.V. Nelson, Applied Science Division of Litton Systems, Inc., August 1965, page 8.

that is, it must be suitably close to the "real" value of the parameter being measured. Second, precision; that is, the datum points should be closely grouped. The requirements were checked using the transmitted data as recorded on the Gould Inc. strip chart recorder through the 720 Hz phase locked loop (PLL) tone decoder. The data were compiled and then processed using a Hewlett-Packard 9810A calculator with Statistics Block 11214A. The results in Hertz for 60 datum points are tabulated in Table 3; they indicated that there was something wrong with the data on the inlet flow channel. At the time it was assumed that the trouble was in the inlet PR-3 reed because both flow data channels were checked with the Litton calibration device and both channels were always within one count of the correct value. However, subsequent flights showed that this was not the case; it will be discussed later. Even though one flow rate channel produced data with an unusually large standard deviation, the flight was a success because it secured a valid sample and support data.

Table 3. Flow Rate Sensor Data: Test 10

Sensor Location	Inlet	Outlet
<u>Units</u>	<u>Hertz</u>	<u>Hertz</u>
Mode	59.75	58.75
Median	59.88	59.00
Mean	64.88	59.00
Variance	136.9	0.6112
Standard Deviation	13.30	0.7818

#### 2.3.4.3 Tests 11 and 12; December

These tests were conducted to assure that the prototype equipment was functioning as expected. Tracing the equipment by serial number in Appendix A shows that the same units were being used; any changes were incorporated into the existing circuit boards or chassis. Test 11, Mission H74-65/H-54X went very smoothly in the command and control sections but the flow rate data was not satisfactory. The spread of each channel's data is a little wide, especially the inlet data. The Hewlett-Packard 9810A with Statistics Block 11214A was used to compile the statistics in Table 4 for over 70 datum points.

The standard deviation of the inlet flow rate data was not too good; yet, the encoder data channels checked out perfectly with the Litton calibration unit (see H74-55/H-45A). It was not logical to assume that all the PR-3 reeds were "bad" yet could be calibrated with the PR-3 recorder systems. So it was decided to set

up the flight system at the environmental chamber at Holloman AFB and examine the circuit with several different reeds operated at a constant flow supplied by the PR Flow Testers (PRFT). This test is documented in Appendix J; the result was an improved flow rate monitoring circuit.

Table 4. Flow Rate Sensor Data: Test 11

Sensor Location	Inlet	Outlet
<u>Units</u>	<u>Hertz</u>	<u>Hertz</u>
Mode	42.5	52.25
Median	44.75	52.25
Mean	45.33	52.29
Variance	7.953	1.868
Standard Deviation	2.820	1.367

Two days after the environmental chamber test, Mission H74-55/H-55X, Test 12 was flown with the encoder circuit modified as documented in Appendix J. Command and control functioned properly and the flow rate data were significantly improved.

Using the Hewlett-Packard 9810A with Statistics Block 11214A and standard data reduction methods, statistics were compiled for the first four flow data sets (see Table 5).

Table 5. Flow Rate Sensor Data: Test 12

Sampler	DFS No. 1		DFS No. 2
Sensor Location	Inlet	Outlet	Outlet
<u>Units</u>	<u>Hertz</u>	<u>Hertz</u>	<u>Hertz</u>
Mode	50.25	57.00	54.25
Median	49.88	56.50	53.50
Mean	49.85	56.18	53.20
Variance	0.7258	1.144	1.788
Standard Deviation	0.8159	1.070	1.337

To further check the quality of this data, the volume (std cu ft) of air passing through the samplers was calculated for each PR-3 for the first 126 min of the flight. This corresponds to the period the balloon was above or at 24.1 km (79.0 kft). For DFS No. 1 the inlet passed 2155 std cu ft and the outlet passed 2202 std cu ft. The outlet of DFS No. 2 showed 2153 std cu ft passing through the sampler. These volumes compare within the accuracy of the system.

#### 2.3.5 IN-USE EQUIPMENT

Two changes were effected in the original sampling equipment. First, the Viable Systems Transmitter and signal conditioner that replaced the Litton transmitter, arrived from the vendor and were tested in a flight configuration, and shipped to the operational field site at Holloman AFB, NM, with appropriate documentation. They were assimilated into the in-use system and precipitated the second change. When the new transmitters were used with the existing 40.35 MHz antenna, the range of acceptable reception was severely decreased. Examination showed that the antenna impedance was much below the specified 50  $\Omega$ . A new antenna (designated DZ) was designed by the author and incorporated into the inventory in October 1974.

### 2.4 Year 1975

The three consecutive successful missions at the end of 1974 completed the "experimental circuitry" phase and allowed 1975 to be a period of operational testing and mechanical fine tuning. The principal objectives were to finalize and document the circuit layouts and to convert as much circuitry as possible to printed wire board while fabricating more equipment to ensure design repeatability. Minor changes which enhanced the workability of a chosen approach will not be discussed but any new approach to deal with an unforeseen problem will be documented.

#### 2.4.1 CONTROL CHANGE

Over several flights there was an intermittent phenomenon involving the separation devices. Two of these squib activated devices, named "Tenney release devices" after the machinist who developed them, are located at the parachute apex; one is activated by the primary controller and the other by the backup controller (see Figure 12). From October 1974, when the backup controller was introduced to April 1975, both devices were activated on four out of the five free balloon missions. An examination of the problem (see Appendix K) disclosed that a ground loop had inadvertently been formed through the metal devices which would cause both to be activated. Keeping the devices electrically isolated solved the problem and became standard practice on all AFGL balloon missions. Figure 13 shows the new arrangement. Notice that each device is secured with a clevis to either the balloon or the parachute to preclude dropping it.

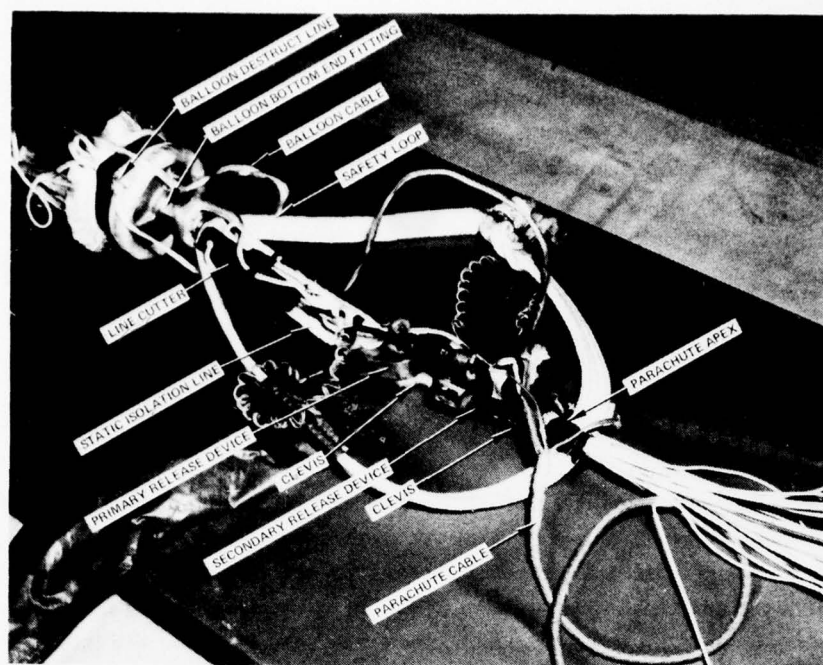


Figure 12. Tenney Release Devices - Original Configuration

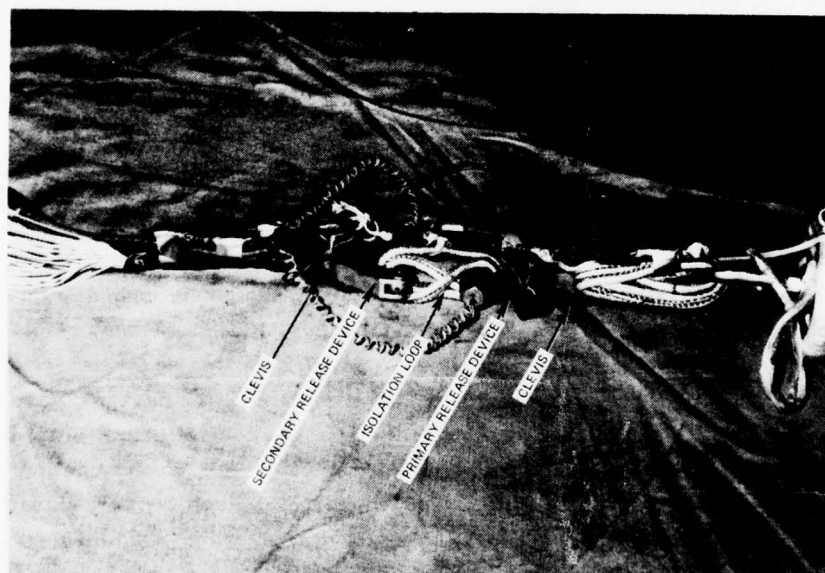


Figure 13. Tenney Release Devices - Present Configuration

#### 2.4.2 DATA SYSTEM CHANGE

Examination of temperature data from both the in-use and new instrumentation showed evidence of a certain amount of almost sinusoidal oscillation of temperature about the average temperature. In an effort to locate a cause of this phenomenon, tests were conducted and it was proven that at the colder temperatures where the thermistor resistance was highest radio frequency (RF) energy would have an effect on the data. Lower resistance thermistors were ordered to eliminate this RF effect on future missions. However, due to the timing of the thermistors' arrival they were not used with the SCADS-2 encoder until 1976. Reference 13 discusses the effect of changing thermistors on the original system.

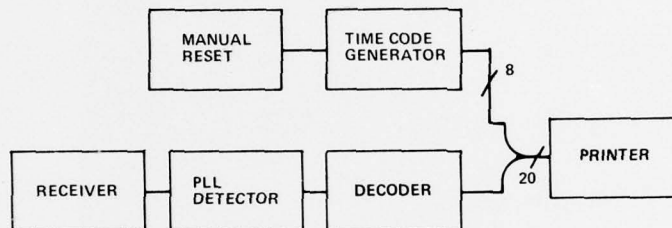


Figure 14.  
Ground Station:  
Present Configuration

#### 2.4.3 THE GROUND STATION

A new receiver, the TMR-1L by Regency Electronics, Inc., was received and tested early in the year. This small, inexpensive, efficient unit had much better sensitivity than the specifications, and, after operational use in April, several more units were purchased. They have been used very successfully to this date.

In July, the interim ground station mentioned in Section 2.2.4 was replaced with the present automatic ground station diagramed in Figure 14. The design utilizes the same approach as the balloon-borne printer interface but takes advantage of the printer's AC capability. Mr. Alan R. Griffin, AFGL/LCC, accomplished the final electrical and mechanical design and supervised the fabrication of the initial unit (Figure 15). The automatic ground station frees Control Center personnel from the requirement to know Morse Code; the data words are read from the printer and decoded in the dictionaries mentioned in Section 2.3.2. During a normal mission, only channels 1 and 2, primary altitude and housekeeping, are monitored continuously. No difficulties have been experienced since it was introduced into the SCADS-2; so it will not be discussed with the individual flights.

18. Cordella, R. H., Jr., Capt (1977) An Examination of the Temperature Measuring Accuracy of a Flowmeter System Used with Balloon-Borne Atmospheric Samplers, AFGL-TR-77-0034.

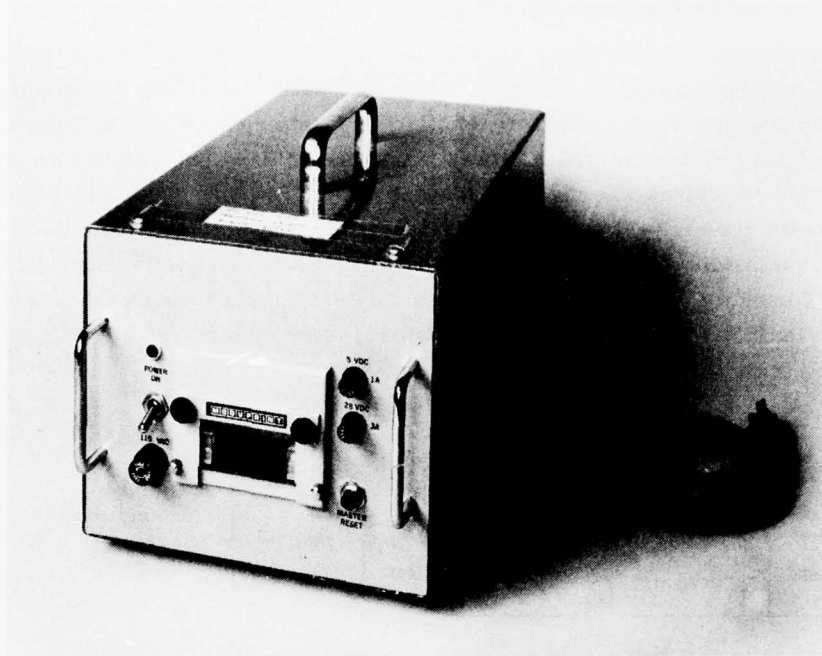


Figure 15. Ground Station (Less Receiver)

#### 2.4.4 TEST EQUIPMENT

Until the middle of 1975 only the control functions had a set of test equipment. Then, with the system undergoing operational testing, assurance was needed that the encoder was functioning properly. An encoder test set was designed to fill this need. Because the encoder monitored signals from so many active devices (primary controller, primary and backup altitude sensors, flow sensors), the test set was built around a signal generator which simulated the signals which these devices produced. The generator is an active device itself and requires a 13-V source to supply about 100 mA. It can test the encoder separately, or, after it has been installed in the instrumentation frame; plus, it can test the data cable. When used in conjunction with the "Model Thermistor UUB31J1" described in Reference 18, it can check the accuracy of the temperature measuring circuit. Complete documentation is available in Reference 14.

#### 2.4.5 SAMPLING EQUIPMENT ACRONYMS

As the developmental equipment was expanded and began to assume part of the operational tests, confusion was generated because there was no terminology for the various equipment and gondolas. They were alternately called old, in-use, new, etc., including various office symbols and surnames. On 12 August 1975 the author published two memos for record which proposed the acronyms SCADS for sampler control and data system, and SAVE for sampler vehicle. These names have been adopted for the project equipment. Table 6 defines the instruments in SCADS-1a, 1b, and 2; SCADS-2a is not yet available. The gondolas were numbered 1 for the original frame, 2 for a gondola developed at the operational detachment, and 3 for the gondola developed by Mr. C. Mitropoulos of AFGL/SURE. Presently, SAVE-SAVE-3a's are being used. Table 6 lists the equipment designated by the SCADS numbers.

Table 6. Instrumentation and Configuration

Item		SCADS			
		1a	1b	2	2a
	Primary System				
Receivers	Raven, 6 ch	X	X		
	Zenith, 9 ch			X	
	Raven, 12 ch				X
Transmitters	SST-14	X			
	SC-1		X		
	FMT-1A		X	X	X
Flight Regulators	Control Unit	X	X		
	Controller			X	X
	High Current Switch			X	X
Altitude Sensors	B-60	X	X	X	X
	B-34	X	X		
	Rosemount			X	X
Data Systems	PR-3 Flowmeter System	X	X		
	PR-3 Flow Sensor	X	X	X	X
	Frequency Encoder			X	X
	Printer w/Interface			X	X
Homing	242-MHz Beacon	X	X	X	X
	Back-Up System				
Receiver	Zenith, 3 ch	X	X	X	X
	Timer	X	X		
	b/u Controller			X	X

#### 2.4.6 OPERATIONAL FLIGHTS

At this point SCADS-2 was considered to be out of the developmental state and fit for operational missions; therefore the suffix "X" for experiment was dropped from the mission number. In the interest of clarity, I will continue to refer to the test numbers assigned consecutively in Appendix A.

##### 2.4.6.1 Tests 13 and 14; April

These tests were so similar that except for their altitude one set of comments can suffice for both. The former mission was to 21.3 km (70 kft) and the latter to 24.4 km (80 kft). The primary objective was to obtain atmospheric samples; the secondary objective was to further qualify the new Ash Can electronics systems. Four new instrumentation features were: (1) two high current switches and three 24-V BB405 battery packs were used to power three DFS's; (2) the Air Serve Valve which controls the DFS doors was controlled directly from the primary instrumentation; (3) both two-wire and three-wire Skinner magnetic latch valves\* were controlled simultaneously; and (4) a new telemetry receiver (Regency model TMR-IL)

The extra 24-V pack of BB405's necessitated placing the backup instrumentation on top of the primary instrumentation so its usual position could be used for the extra batteries. This configuration kept the center of gravity as low as possible.

The direct control of the Air Serve Valve, which requires 24 V, enabled the batteries for the DFS to be tapped at 22.5 volts. This reduced the current drain to approximately 17 A which resulted in the battery-voltage remaining at the plateau voltage for over 4.25 hr (reference Eagle-Pitcher data). This was corroborated by the DFS flow rates being very stable over the entire 4-hr sample time.

The data were of excellent quality and the telemetry signal was clear. All flight objectives, primary and secondary, were met.

##### 2.4.6.2 Tests 15, 16, and 17; July

These three flights were successful in that they secured specimens and support data according to the flight plan; and, with the completion of No. 17 there were eight consecutive successful flights. However, none of the three were perfect; each had a slight flaw in the data system function. Rather than try to disregard the insight gained with the passage of time, I will relate the discrepancies, their former interpretation, and their present interpretation. A slight digression into the encoder format will be necessary.

When the encoder format was outlined in Section 2.3.2, it was described how the first three channels were dedicated to flight information and the last 12 channels were dedicated to sampler information. It was not mentioned that a capability exists

---

\* These valves control the compressed gas which drives the C-14 samplers.

to continuously cycle only the first three channels plus the framing pulse which precedes them. This provides altitude data about every 25 sec and is used at the beginning of each flight to monitor balloon ascent. The encoder is set in this mode automatically when power is applied. After the system is about 3 to 6 km (10-20 kft) in altitude the encoder mode is switched by radio command to the full 15 channel mode which is repeated every 3 min as keyed from the primary controller. This is usually used for the remainder of the flight or until the system is on the recovery parachute. The modes can be switched as often as desired by using the command capability.

On test 15, after the balloon was released from the launch device, the encoder ended up in the full data mode and, for the first 10 min of the flight, the message format (15 twelve-bit words every 3 min) was itself disrupted. After that, the flight was perfect. At that time this erroneous performance was attributed to a C-band transponder which was placed on the gondola to allow White Sands Missile Range to track the balloon. However, even though this interference could not be duplicated, ceramic by-pass capacitors were added on the input which controlled the encoder message length.

Test 16 system did not include a transponder and the flight was virtually perfect. This firmed the opinion that the interference on the previous mission was caused by the transponder. (It is now believed that it was radio frequency interference (RFI) from the 40.35 MHz transmitter.)

Test 17 again had a C-band transponder; some intermittent data transmission was noted during the very early part of the ascent. This was, at that time, attributed to a malfunctioning transmitting antenna because it had become badly twisted just after balloon release but was seen to untangle as the system ascended. This untangling coincided with the resumption of normal telemetry; the remainder of the flight was perfect. Because these deviations from the normal scheme were so minor and could not be attributed to any specific system malfunction, they were documented as being linked to the transponder and largely forgotten. However, the next two attempts at flights using SCADS-2 were to reopen the question.

#### 2.4.6.3 Tests 18 and 19; October

These two tests were catastrophic failures. Since the preceding eight SCADS-2 missions were successful and training of the operational test site personnel was proceeding smoothly, the author was not at the operational site when Test 18 was launched. The following facts are from the "Post Mission Evaluation and Critique for Flight H75-42/H-69" by J. Robert Greenlee, 1/Lt, USAF, the operational project officer.

"Mission Objectives" were to collect atmospheric samples at 21.3 km (70 kft). However, due to a premature termination by the SCADS-2 instrumentation system, the balloon was not successfully launched and mission objectives were not satisfied.

Preparation of the SCADS-2 instrumentation system (Serial No. 01) and SAVE-3 gondola proceeded smoothly and on schedule during the entire week before the launch. At no time during the package checkout were difficulties encountered. In fact, it is noteworthy that the entire pre-launch operation proceeded smoothly and according to schedule. When the package was turned on after balloon inflation, the 40.35 MHz telemetry signal was received loud and clear in the Control Center and in the instrumentation van on the line, and the good signal continued until bubble release. At that time, with the launch vehicle brakes still set, the signal became very garbled and unreadable (only intermittent noise spikes appear on the strip chart recorder). This condition lasted for several seconds and is followed on the strip chart recording by dashing, indicating the primary instrumentation to be in the termination sequence. Personnel monitoring the signal during the launch run, both in the Control Center and in the instrumentation van, heard the dashing and realized its significance, but before anything could be done to notify the crew chief, and before release from the BST\* took place, the backup Tenney device fired, separating the parachute and balloon. The parachute fell around the payload (which was still attached to the BST) and was then pulled upwards by the ripline as the balloon ascended. During this process a parachute suspension line became entangled around the radiosonde, ripping it from the payload when the parachute was pulled vertically. The ripline system and ripline cutter worked properly, and the balloon came to rest about 50 ft from the taxiway. An immediate inspection of the system showed that the ballast-blow patch squib fired, the balloon valve was open, and the parachute burst pin was not pulled. The SCADS-2 package continued to transmit until it was turned off, and a post flight inspection of the strip chart recording by Capt. Cordella showed that the package was in "long" cycle after the incident, although primary channel 1 (Encoder Key) had not been issued.

Inspection of the movies also revealed that about 30 sec passed from the moment of bubble release until the backup tenney squib fired. Following the launch attempt the payload and the balloon were returned to the site laboratory. A post mission analysis of the payload malfunction was begun immediately with the payload completely intact and undisturbed. Both the primary and backup packages checked out perfectly and absolutely no discrepancies in performance were noted. Discussions were initiated immediately with Capt. Cordella, and based on his suggestions several additional areas were investigated, but nothing was found which helped to explain the problem. Capt. Cordella arrived on 17 October to take over the investigation, which continued until 20 October.

The facts, when reviewed in the light of the July series which had been conducted with the same instruments, led to the conclusion that this was an isolated

---

\*BST: The launch vehicle which held the sampling system prior to launch.

failure caused at bubble release by a discharge of static electricity. The failure affected the primary controller by causing it to go into the termination mode, the encoder, by causing it to go into its "long cycle", and the backup controller, by causing it to go into its termination mode. A further conclusion was that the failure was not indicative of a system problem. The decision was made to fly the SCADS-2 sn 02 with the following precautions:

- (a) The telemetry receiver would be patched into the magnetic tape recorder to preclude loss of data,
- (b) The length of the static isolation strap would be lengthened to approximately 4 ft (see Figure 16),
- (c) Procedures were set up to attempt to de-energize the instrumentation if the system went into termination at bubble release.

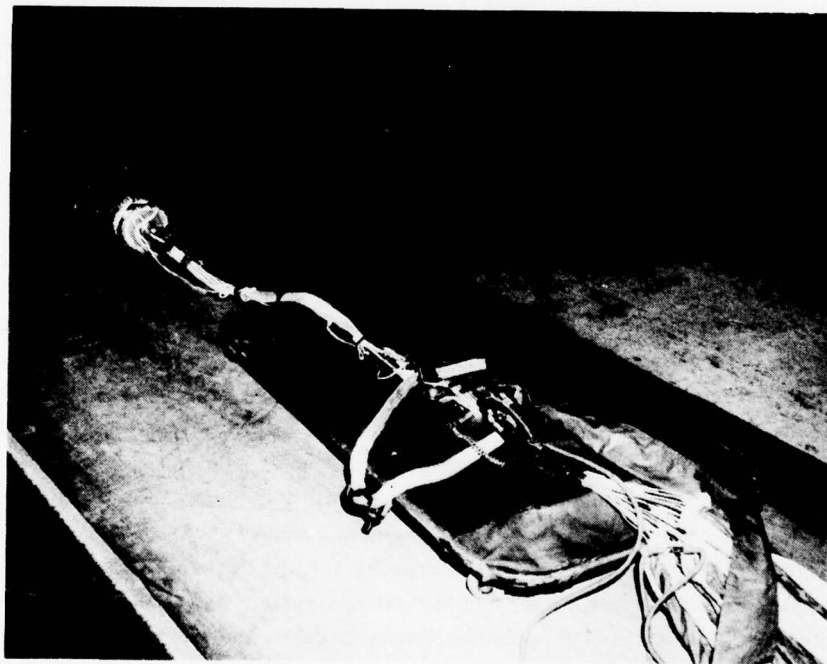


Figure 16. Isolation Strap at BottomEnd Fitting

The objective of Test 19 was to obtain atmospheric samples at 24.4 km (80 kft). Preparation for flight H75-43/H70 proceeded according to the normal instrumentation

check list, albeit very thoroughly. All checks were correct and on 20 October 1975 the system was launched following a perfect preflight checkout. A receiver was positioned on the flight line to facilitate observation of the transmitted data. At bubble release a high frequency tone was noted in the background of the FM transmission. The data could still be clearly heard over this tone and was copied by the phase locked loop filtered recorder in the control center. It was not noticed at the time, but the transmitted format of the last word in thirteenth message was garbled in that some of the bits were run together. The instrumentation initiated a premature termination sequence within moments of system release; separation occurred shortly thereafter. System altitude at the moment of separation was not sufficient to allow proper parachute deployment and the payload impacted several yards north of the runway. Extensive damage was imparted to the system and mission objectives were not satisfied.

The utilization of the same instrumentation packages on the October and July flights with such incompatible results prompted a comparison of the overall configuration in the hope that some differences would be found. The comparison of the five flights was conducted with inputs from as many personnel of all sections as could attend the meeting. Items compared were balloons, rip-line cutters, gas valves, Tenney device configurations, static isolating strap length, launch arm, gondola type, instrumentation type and serial number, cable configuration, relative humidity, types and numbers of samplers, and presence of C-band transponder. The July and October flight configurations were so similar that the weight of the 24.4 km (80 kft) July flight and 21.3 km (70 kft) October flight were within 4.5 kg (10 lb). Notable differences are balloon type and the direct flow sampler door monitor. The direct flow sampler door monitor switch was first used in October. Its purpose is to report when the sampler doors are not completely closed.

It was determined that the exact cause of the two failures may never be known but that the extensive testing necessary could be more readily accomplished at the home laboratory rather than at the test site facilities.

The information gathered pointed to two possible causes of the premature terminations, static electricity and radio frequency interference. Each cause is virtually impossible to duplicate in the laboratory and the behavior of each is associated with rapid changes in the geometry of the balloon system at bubble release and trip-line release. The static charge redistributes itself on the moving balloon system and the electromagnetic field from the transmitting antenna assumes a new shape as the balloon pulls the system upright. The most likely candidate for the problem is the radio frequency interference (RFI) from the 40.35-MHz transmitter. However, static electricity could not be ruled out because of the coincidence of the problem and balloon movement. Since extensive RFI protection in the instruments would protect against static electricity, also this approach was taken in preparation

for a tethered test. Conclusions based on the information on hand in late October were:

- (a) The tone in the background of the data transmission was caused by the mismatching of the antenna when it was handled by the instrumentation technician prior to launch. (This proved to be correct.) An attempted fix was to use a different antenna, a modified Zepp antenna, with an antenna chute. (This proved to be a partial fix and will be explained later.)
- (b) The "clock" inputs of CMOS chips were more susceptible to RF than the inputs of gates and needed more protection than has been supplied.
- (c) The base-emitter junctions of transistors were far more susceptible to RF than the CMOS logic. These junctions could be protected by bypass capacitors and a bias voltage supplied by a Zener diode (see Figure 17).

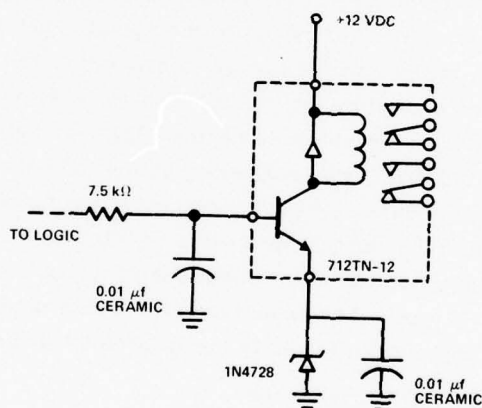


Figure 17. Typical Relay Driver Protection

- (d) The direct flow sampler door monitor switch was incorporated in a fashion that left the encoder circuit open. The thermistor was connected to the encoder by a twisted shielded pair of wires, and a normally open switch was inserted in series with the thermistor. Opening the DFS door closed the switch. This was changed so that

the thermistor always terminates the line pair with a normally closed switch in parallel. The switch opens when the DFS door opens. The original method provided an easy path for RF energy to enter the instrumentation. The second method eliminates this hazard.

Instrumentation changes accomplished for RFI protection are the addition of ceramic capacitors to act as RF filters on control lines, addition of a 4-sec delay on the termination command, and lowering the value of the pullup resistors for the control signal lines from the selector. To accomplish the latter, the voltage regulators in the controller and encoder were modified to increase their current capability. Also, to protect the base-emitter junction of the transistors internal to the Teledyne 712TN-12 relays, a Zener diode was placed in series with the emitter lead. It was not possible to incorporate this modification on all the relays prior to the next test because of the difficulty of adding components to printed circuits (PC) boards. The diodes were added only where the relay directly controlled squibs with the understanding that the PC board would be reaccomplished to accommodate a protective diode for each relay. During testing it was noted that the instrumentation could not be affected by coupling RF energy into the cables, or by injecting it directly into connectors for data or control cables with a signal generator. However, by using the output of the FMT-1a transmitter through a capacitor, the transmitted data could be obscured. This was caused by the high RF energy level on the ground plane keeping the transistor in the transmitter keying 712TN-12 relay energized. Checking the CMOS logic revealed that it was unaffected by the RF energy and was performing properly. The controller could not be made to enter the termination mode by using RF energy. The severity of the test necessary to introduce this keying malfunction was interpreted to imply that such a problem during a flight was almost impossible. Also, in the future, TN type relays would have the Zener diode protection. An operational test was now needed to verify the laboratory findings.

#### 2.4.6.4 Tests 20 and 21; December

The purpose of the first flight was to provide a tethered balloon platform for detailed equipment checkout of the SCADS-2 instrumentation system. Non-conductive cables were used to anchor the tethered balloon, because a primary area of instrumentation investigation was RF susceptibility. The new reel-deployable 40.35 MHz Zepp antenna was tested and operated successfully. It was determined that the command method of changing message lengths was well protected but the automatic method of putting the encoder into the complete message mode only afforded minimal protection. The quality of this protection was increased prior to 1976 flights. All mission objectives were satisfied, and based on the positive results of this mission, planning proceeded toward a free balloon test flight.

As can be seen in Appendix A, the same equipment was used on the next Mission, H75-54/H-76X, as was used on the second October flight which failed; only the circuit modification documented in Section 2.4.6.3 and the transmitting antenna were different. This mission was to further test and flight-qualify the SCADS-2 system, to collect DFS samples, and to flight-qualify the newly designed reel-deployable, 40.35 MHz transmitter antenna. All mission objectives were satisfied with the successful collection of a 3-hr sample by both DFS experiments at 18.3 km. Deployment and operation of the antenna was entirely satisfactory. The instrumentation system collected the requisite collateral data via the on-board printer, but a telemetry problem developed which precluded real time data collection.

The loss of transmitted data was caused by RF energy keeping the output relay in the encoder energized after its input signal had returned to ground potential. This relay is of the Teledyne 712TN-12 type discussed in Section 2.4.6.4. There are two theories: first, as the balloon rises into the less dense air, the field of transmitting antenna changes because of the varying properties of the atmosphere such as density or ionization potential; second, as the system goes further from the earth, the field of the transmitting antenna changes because of the system capacitance between the balloon payload and the earth. In either case the results are increased RF energy induced into the instrumentation. The addition of protective Zener diodes eliminated the problem. Realizing that the effects of the radiated RF energy must be minimized, it was decided that the instrumentation would be shielded and have RF filter connectors on the cables entering or leaving the instrumentation frame or the backup controller. However, after researching connector cost, it was decided to use ferrite beads mounted in small boxes to reduce the level of the RF energy (see Figure 18).

In conclusion, problems experienced by SCADS-2 instrumentation to this time were documented, explained and corrected. The next free balloon mission would prove or disprove the effectiveness of the measures taken because, as demonstrated, this type of problem is extremely difficult to duplicate in the laboratory or on tethered balloons.

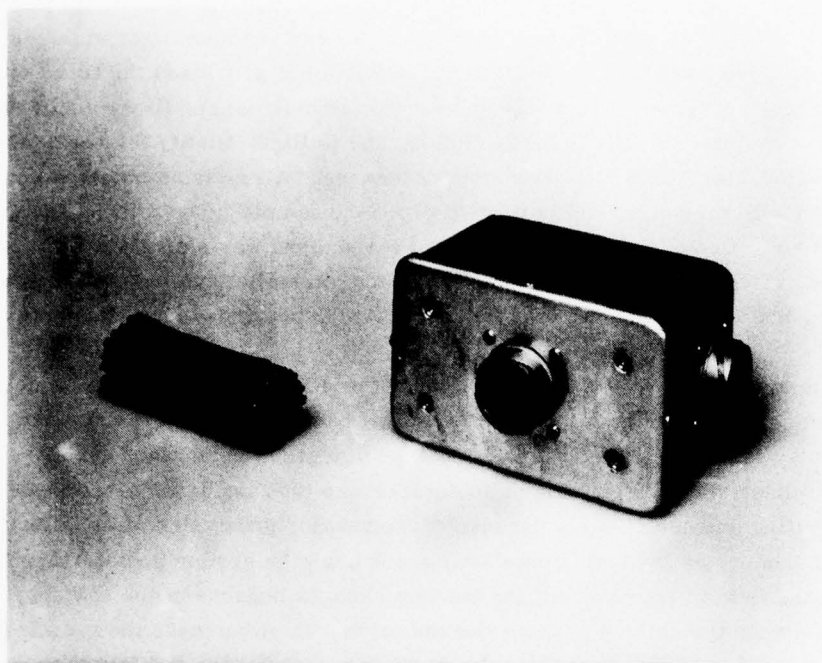


Figure 18. RFI Filter: Ferrite Beads

#### 2.4.7 IN-USE EQUIPMENT

The "high frequency tone" described in Section 2.4.6.3 had occurred briefly at other balloon launchings when the FMT-1a transmitter was used and, on tethered Test 20, the fuse protecting the transmitter was blown during the preflight checkout while the antenna was being handled. This problem was examined at the test site laboratory and at AFGL and the symptoms were duplicated. Tests showed that the cause was a mismatch in the antenna impedance because of a marginal design in the output stages of the transmitter. This problem has been eliminated by the insertion of a 50-MHz low pass filter between the transmitter output and the antenna feed coaxial cable. This filter must be firmly and securely grounded to the same ground plate as the transmitter. The initial flights of this filter with an FMT-1a sn (008) and a reel deployable FM antenna (H76-03 and H76-05) were excellent. The filter solved both problems. The transmitter must now be tuned with the filter in place. Further experimentation at LCC demonstrated that the HF filters flown with the Zenith and Viable receivers must also be securely grounded to be effective. This should be accomplished by physically securing them to the instrumentation frame or using a heavy gauge ground strap.

A problem which did not affect any of the flights directly, but did postpone the launch of Test 21 occurred on 18 November. Receiver/selector performance was noted to be incorrect in that the selector became locked onto the first channel which was energized, and subsequently, issuing the command for any channel resulted in the selection of the channel initially selected. The receiver/selector problem was duplicated in the laboratory by placing the receiver and transmitter antennas in close proximity to each other and then trying to select commands while the transmitter was radiating through its antenna. Radiated RF energy developed a voltage across the diode on the output of the operational amplifier in the reed switch command decoder box. This added voltage would latch the amplifier into its "on" position precluding selection of other commands. This problem was solved by the addition of ceramic 0.01  $\mu$ m capacitors from both sides of the diode and series resistor to ground on each operational amplifier output. Capacitors were also added to the audio input line and the voltage regulator. All resonant reed decoders were subsequently modified.

A memo on operating power source current requirements for the DFS's (Appendix C) was written in this year and in October a design to modify some SCADS-1a control units to handle three DFS's was formulated from this location.

In September there were extensive discussions about the accuracy and repeatability of the PR-3 flowmeter system. These discussions were instrumental in the decision to change the thermistor and document the results.<sup>18</sup>

## 2.5 Year 1976

The preceding development and test effort paved the way for defining the system. Therefore, all system documentation was reviewed and reaccomplished where necessary.<sup>14</sup> All of the preceding year's flights fell under the configuration of Figure B7. The addition of the RF filters on the data, control and power cables plus the low pass filter on the Viable 40.35-Mhz transmitter changed the configuration to that shown in Figure B8.

### 2.5.1 CONTROL CHANGES

There was one addition to the system's control capability; a burst monitor switch was added. This circuit enables the flight director to disable the burst switch circuit by radio command before the system has reached the circuit arming altitude. The need for this capability could arise if the burst pin was inadvertently pulled at launch and was therefore incorrectly indicating that the system was

---

18. Cordella, R. H., Jr., Capt (1977) An Examination of the Temperature Measuring Accuracy of a Flowmeter System Used with Balloon-Borne Atmospheric Samplers, AFGL-TR-77-0034.

descending. This very rarely happens but a gust of wind can inflate the parachute at launch, causing the pin to be pulled from the switch housing (see Figure 19).



Figure 19. Burst Pin Assembly on Parachute

An important component which does not show up on the schematics but which is essential to the physical configuration of the equipment is the printed circuit (PC) work. With the finalizing of the circuits all PC boards were reviewed and several were reaccomplished to correct component spacing, etc. This is further documented in Section 2.5.4.1.

#### 2.5.2 DATA SYSTEM CHANGES

There was one principal data system change which necessitated several small adjustments. In March, the encoder circuit which monitors the PR-3 flow sensor thermistor was modified to accept a Fenwal bead thermistor—UUB31J1. To fully utilize the potential of the curve-matched thermistor, the temperature measuring circuit was modified so that a set of individual circuits could be adjusted to within an acceptable accuracy envelope. A major benefit is the ability to use one temperature dictionary (Appendix G) for all the encoders. The modification was extremely

simple and left the circuit topology unchanged. Two fixed resistors in the temperature scaling circuit were replaced with variable resistances. Each resistance acts upon the circuit in a basically independent fashion; one changes the warmest indicated temperatures, and the other, the coldest indicated temperatures. Each extreme was adjusted for zero error according to the dictionary. The accuracy envelope for the encoders on-hand was  $\pm 0.7^{\circ}\text{C}$  over the temperature range  $+20^{\circ}\text{C}$  to  $-80^{\circ}\text{C}$ .

After these changes were accomplished, tested, and documented, the encoder test set was modified to accommodate the bead thermistor resistances.

#### 2.5.3 SENSORS

As mentioned earlier, the search for a follow-on primary altitude sensor never really ended. Several new digital pressure transducers, the Hamilton Standard Model-1D, were ordered for evaluation. Apparently these devices are stable enough to be standards themselves; therefore, if they function over the pressures experienced between sea level and 40 km they may eventually replace the B-60's.<sup>19</sup>

#### 2.5.4 OPERATIONAL FLIGHTS

After the experience gained at the end of 1975, the prognosis was for quick conformation of the "fix" described in the previous year documentation. The SAVE-3 gondola was utilized (see Figure 20). Compare it to Figure 6 and note the lower center of gravity obtained by moving the ballast hopper up on either side of the batteries.

##### 2.5.4.1 Test 22; April

Mission H76-19/H-84X was to be a routine sampling mission to 18.3 km (60 kft). After a smooth checkout, launch and antenna deployment; the primary controller went into the termination mode, ending the flight at 10 kft altitude. At impact the parachute draped over 22-kV lines causing extensive damage to the system cables and instruments. Checking the circuits for the problem disclosed that the impact switch circuit was in error; that is, it was not fabricated in accordance with the documentation. Therefore, all system documentation was inspected and all hardware was checked by at least two people for compliance to the prints. This check included circuit topology and component values. The system was rebuilt and underwent rigorous laboratory testing.

---

19. Cordella, R. H., Jr., Capt (1978) An Autoranging Balloon Altimeter: A Single Pressure Transducer Monitors Altitude from 0 to 44 Kilometers with 30 Meters Resolution, AFGL-TR-78-0023.

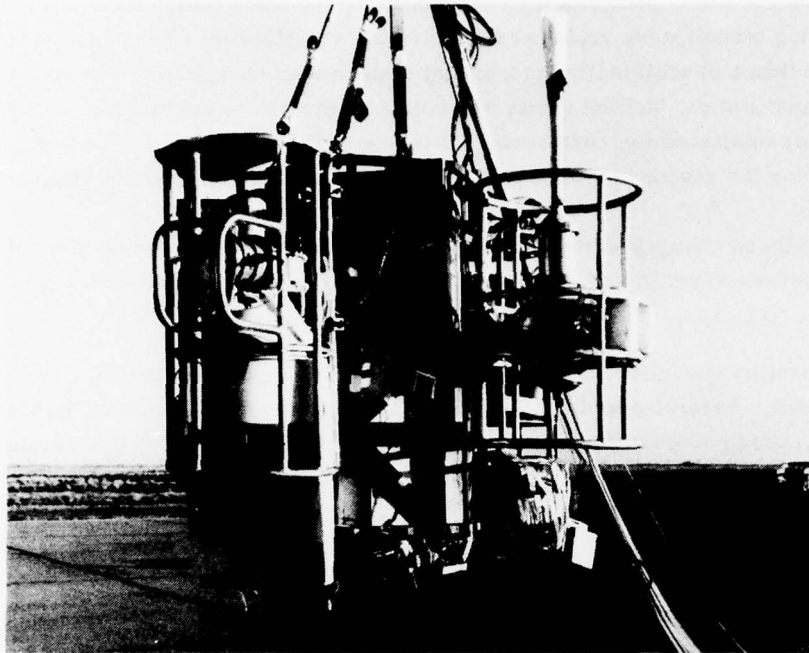


Figure 20. Gondola: SAVE-3

#### 2.5.4.2 Tests 23 and 24; November

A comprehensive RFI test was scheduled before a free-balloon flight. All normal radiators would be operated on the flight system simultaneously. The radiating equipments were a radiosonde, FMT-1a transmitter, homing beacon, FAA transponder, and C-band transponder. The system was prepared as if it were to be a free flight and a condensed sequence of commands and timer initiated events was scheduled to simulate a complete mission. The results of Test 23, Mission H76-65/H-102X were perfect.

The sequence of command and timer activated events were completed as scheduled in a flawless manner. The data tapes for the flight recorder, ground recorder, and a phase locked loop detected strip chart record of the audio were compared on this date. The data on the flight and ground station tapes corresponded within the resolution of a digital system ( $\pm 1/2$  bit). The data on the ground recorder were interrupted by the replies from the Zenith receiver/selector system. This was confirmed by referring to the strip chart record. There was no hint of RF interference in the data or time code portions of the flight recorder tape. The replies from the FAA and C-band transponders were clearly received by the

appropriate agencies during the test. The previously experienced RFI problems (on flights H-69, H-70, H-75X, H-76X) had either been solved or were such that they could not be explored by this type of test.

Test 24 was ready for launching 3 days after the tethered balloon test. A 4-hr sampling mission was successfully accomplished. Three specimens and support data were gathered; data quality was excellent; the control system performed flawlessly.

The automatic ground station recorded data for the entire mission until the system was below about 6.1 km (20 kft) on the parachute. This loss of signal as the parachute returns the system to earth is normal when the instruments pass below the radio horizon.

#### 2.5.5 COMMENTS

Other sampling missions were planned for the remainder of 1976 but this instrumentation system was virtually destroyed when the parachute contacted a 345-kV power line northeast of Truth or Consequences, New Mexico. After having almost three complete systems in October 1975, we now had no operational equipment left that could be flown without extensive rehabilitation.

#### 2.5.6 IN-USE EQUIPMENT

Several changes to the SCADS-1a system were accomplished; none were foreseen at the beginning of the project but the delay in introducing SCADS-2 in operationally significant numbers required action.

The control units which had been transferred to AFGL (then AFCRL) in the early 1970's were very well worn and required extensive maintenance or replacement. Therefore, new control units were fabricated at the field test site at Holloman AFB, NM. These units were schematically identical to the units being replaced. With two exceptions, first, several of the new control units had the capability to control three DFS's; second, each unit could control a ballast hopper in lieu of the quantized ballast slugs. The control of three DFS's was instituted in 1975 for some of the control units and it was carried forward into the new units. These units have been in use since early 1976 and are functioning properly.

To facilitate calculation of the capacity of BB405 batteries for the DFS, a graphical tool was designed and distributed to the field test site, (see Appendix C).

As mentioned earlier, new FM 40.35-MHz receivers had been procured for the field test site. Prior to shipment to Holloman AFB, an emitter follower amplifier was added to the discriminator output to facilitate the operation of the SCAD-1a ground station. The amplifier precluded the necessity of the data going through the audio amplifier which drives the receiver speaker, resulting in a much cleaner signal. A second benefit is that the receiver volume may be varied without distributing the signal to the ground station.

Between February and August three test flights of the Fenwal bead thermistor in the PR-3 flowmeter system were accomplished. Based on the results of these flights this thermistor was adopted for routine PR-3 use. This will result in improved data now, and will prepare the flow sensors for operation with the SCADS-2 encoder. Results of the tests are documented in Reference 18.

### 3. COMMENTS AND CONCLUSIONS

#### 3.1 Objectives

The initial objectives stated in Section 1.5 were met and exceeded in both the ground equipment and the flight equipment. In the flight equipment, the control system was tailored to the existing control devices and balloon equipment, and the data system was tailored to the in-use sensors. In both cases the performance of SCADS-2 equipment surpasses SCADS-1a equipment. The SAVE-3 gondola provides a central core on which to assemble repeatable flight configurations. The automatic ground station provides a complete record of the flight, with time codes, and requires no attention after the time code generator is synchronized.

#### 3.2 Documentation

The instrumentation and supporting software are fully documented. Volume 2 of the project handbook<sup>14</sup> contains over two hundred pages of schematics, wiring tables, and parts layouts and lists. The computer programs are documented in the appendices to this report. Also the accuracies of the principal sensors are defined; the B-60 altitude sensor in Table 2, the PR-3 flow sensor in Appendix J and the PR-3 temperature sensors in Section 2.5.2.

#### 3.3 Functional Verification

Nine pieces of test equipment and a comprehensive test procedure have been provided to facilitate extensive inspection before a mission.

#### 3.4 Additional Flights

Beginning in late 1976 arrangements were made to have New Mexico State University, Physical Science Laboratory, fabricate and operate the SCADS-2. Using AFGL documentation<sup>14</sup> plus a physical model, University personnel fabricated a complete SCADS-2 by mid-1977. In this context "complete" means flight hardware exclusive of transmitters and receivers, test equipment, and a ground station. Simultaneously, AFGL personnel fabricated a new set of flight equipment. In early August 1977, an extensive series of bench tests using both AFGL and University

fabricated equipment established the interchangeability of all component modules between the two systems and certified their operational readiness.

During the remainder of 1977 two operational missions were performed with each set of equipment. The results were very gratifying; the SCADS-2 performed perfectly on each mission.

## References

1. Cordella, R. H., Jr., Capt (1974) A control and telemetry system for a balloon-borne air sampling package, Proceedings, Eighth AFCRL Scientific Balloon Symposium, 30 September to 3 October 1974, AFCRL-TR-74-0393, pp 451-476.
2. Instruction Book: Command Receiver/Decoder, Raven Industries, Inc., Box 1007, Sioux Falls, South Dakota 57101.
3. Handbook of Instructions for Dual Frequency Command Receiver BCR-4B, Developed for Air Force Cambridge Research Center, Air Research and Development Command, Bedford, MA 01731, under Contract No. F19650-67-0053, 15 March 1967. Manufactured by Military Division, Zenith Radio Corporation, 6501 West Grand Avenue, Chicago, Illinois 60635.
4. Final Engineering Report on Command Selector BCS-2A-3818, Prepared for Electronic Systems Division, AFCRL(AFSC), Laurence G. Hanscom Field, Bedford, MA under Contract No. AF19(628)-3818, 12 December 1964. Government and Special Products Division, Zenith Radio Corporation, 6501 West Grand Avenue, Chicago, Illinois 60635.
5. Handbook of Instructions for Command Receiver BCR-3A-477, developed for AF Cambridge Research Center, Air Research and Development Command, Bedford, MA under Contract No. AF19(628)-477, 15 April 1963, Manufactured by Military Division, Zenith Radio Corporation, 6501 West Grand Avenue, Chicago, Illinois 60635.
6. Handbook of Instructions for Data Transmitter BCG-3A, prepared for AFCRL, Bedford, MA under Contract No. F19650-67-C-0053, 1 March 1967. Military Division, Zenith Radio Corporation, 6501 West Grand Avenue, Chicago, Illinois 60635.
7. SS/T14 Telemetry Transmitter Technical Handbook: ASD Document No. 3335, prepared for Department of the Air Force, Detachment 31, 6th Weather Wing (MAC), Goodfellow AFB, Texas 76901 under Contract No. F41614-69-R-0442, July 1969. Applied Science Division, Litton Systems, Inc., 2003 East Hennepin Avenue, Minneapolis, MN 55413.

## References

8. PR-3 Flowmeter System Technical Handbook: ASD Document No. 3330, prepared by Department of the Air Force, Detachment 31, 6th Weather Wing (MAC), Goodfellow AFB, Texas 76901 under Contract No. F41614-69-R-0442, June 1969. Applied Science Division, Litton Systems, Inc., 2003 East Hennepin Avenue, Minneapolis, MN 55413.
9. Model B-60 Balloon Altitude Sensor, Specification No. SK1595, 28 October 1970. Applied Science Division, Litton Systems, Inc.
10. B-34 Baro-Transmitter Technical Handbook: ASD Document No. 3333 prepared for Department of the Air Force, Detachment 31, 6th Weather Wing (MAC); Goodfellow AFB, Texas 76901 under Contract No. F41614-69-R-0442, July 1969. Applied Science Division, Litton Systems, Inc., 2003 West Hennepin Avenue, Minneapolis, Minnesota 55413.
11. G. E. Silicon Controlled Rectifier Manual, edited by F.W. Gutzwiller, prepared for General Electric Company, 3800 North Milwaukee Avenue, Chicago, Illinois 60641, 1967, pp 153-155.
12. Hi-G Relay Engineering Manual, Document No. REM-1164, by Hi-G Incorporated, Windsor Locks, CO 06096, 1964, pp 6, 7, and 11.
13. Instruction Manual for Model FMT-1A FM Transmitter, AFCRL Contract No. F19650-74-C-0407, May 1974. Viable Systems, Incorporated, 299 Second Avenue, Needham Heights, MA 02194.
14. Cordella, R. H., Jr., Capt (1977) Project Ash Can Atmospheric Sampling Handbook, Volume II, Instrumentation: SCADS-2, AFGL, Aerospace Instrumentation Division, Hanscom AFB, MA 01731.
15. Instruction Manual: Model No. CMMP-6A, July 1973, Practical Automation Inc., Trapp Falls Road, Shelton, CO 06484.
16. The ARRL Antenna Book, published by the American Radio Relay League, Inc., Newington, CO, 1974, pp 108, 109, and 116.
17. Development and Calibration of the PR-3 Flowmeter, ASD Report No. 2723 by R.C. Wood, L.R. Graf, L.V. Nelson, Applied Science Division of Litton Systems, Inc., August 1965, page 8.
18. Cordella, R. H., Jr., Capt (1977) An Examination of the Temperature Measuring Accuracy of a Flowmeter System Used with Balloon-Borne Atmospheric Samplers, AFGL-TR-77-0034.
19. Cordella, R. H., Jr., Capt (1978) An Autoranging Balloon Altimeter: A Single Pressure Transducer Monitors Altitude from 0 to 44 Kilometers with 30 Meters Resolution, AFGL-TR-78-0023.

## Appendix A

### Tabulation of Flight Equipment Usage

This Appendix reviews for each flight the flight equipment and the active samplers. It also proposes two "Figures of Merit" (FOM) to gauge the flights' acceptability. The first FOM, sample acceptability, is strictly binary; sample with data, or fail. The second FOM can vary from 0 to 1 (nothing worked to everything worked) and is an attempt to note the overall instrumentation performance. This numerical indicator is based on 25 points allocated as follows: receiving system 1, controller commands 9 and timer 3, encoder format 5, altitude sensors 2, housekeeping data 1, flow data 1, temperature data 1, recorded data 1, and recorded time code 1.

Table A1. SCADS-2 Flights

TEST NO			FLIGHT NUMBER			DATE			CONTROL UNIT			PRIMARY										SECONDARY		SAMPLERS		FOM		COMMENTS									
												STANDARD					BOTH					LCC										S	B	LCC	BOTH	BOTH	
												B-34	T-14	SC-1	IMPACT SWITCH	PR-3 F/R	PR-3 F/S	FMT-1a	RAVEN RCVR	BEACON	CONTROLLER	IMPACT SWITCH	ZENITH RCVR	ZENITH XMTDR	ENCODER	REORDER	ROSEMOUNT		HCS-RELAY	HCS	TIMER	ZENITH RCVR	VALVE MOD	BACKUP (CNTRL R)	DFS (ACTIVE)	C14	WAS
		TYPE																												SERIAL NO. OR QUANTITY							
1	H72-73 H14X	70																																			
2	H73-17 H-19	80																																			
3	H73-50 H-28X	30 Jul																																			
4	H73-73 H-32	24 Oct																																			
5	H74-27 H-41X	64																																			
6	H74-32	14 Jun																																			
7	H74-36 H-42X	19 Jun																																			
8	H74-55 H-47X	18 Oct																																			
9	H74-56 H-48X	24 Oct																																			
10	H74-61 H-53X	05 Nov																																			
11	H74-65 H-54X	06 Dec																																			
12	H74-66 H-55X	12 Dec																																			
13	H75-23 H-57	09 Apr																																			
14	H75-25 H-59	14 Apr																																			
15	H75-35 H-63	16 Jul																																			
16	H75-36 H-64	20 Jul																																			
17	H75-37 H-65	23 Jul																																			
18	H75-42 H-69	15 Oct																																			
19	H75-43 H-70	20 Oct																																			
20	H75-49 H-75X	14 Nov																																			
21	H75-54 H-76X	02 Dec																																			
22	H76-19 H-84	19 Apr																																			
23	H76-65 H-102X	15 Nov																																			
24	H76-66 H-103X	18 Nov																																			

## Appendix B

### Flight System Configurations

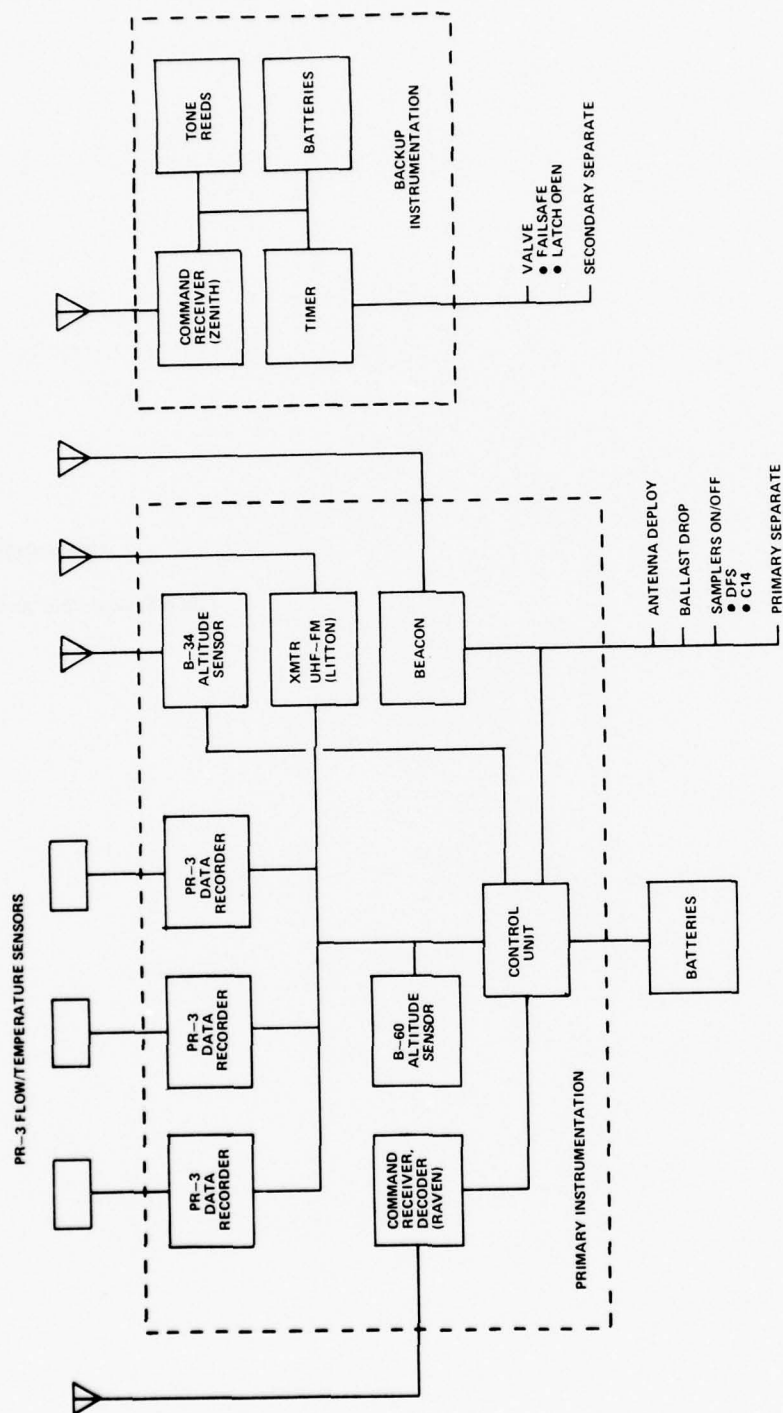


Figure B1. Original System Configuration

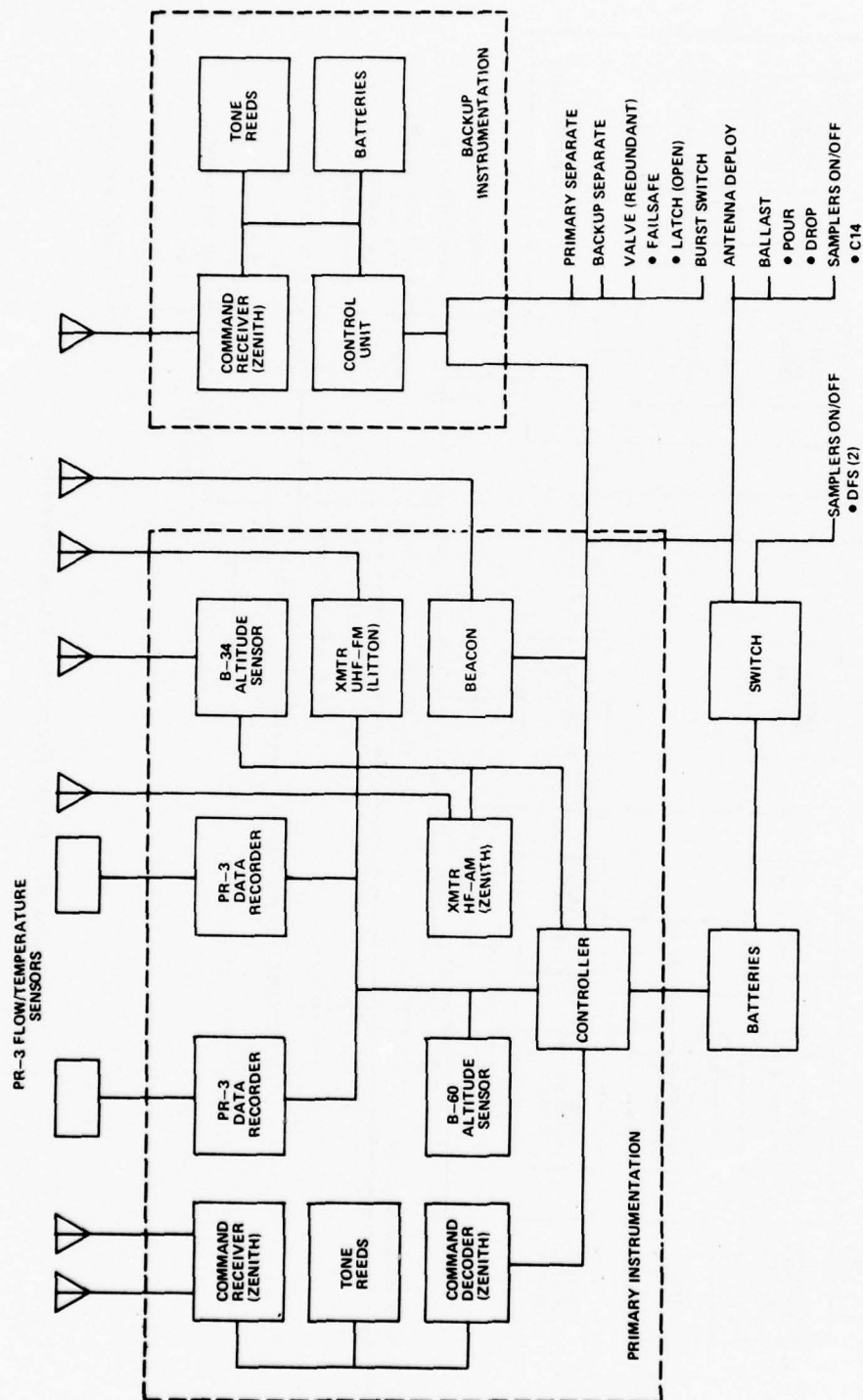


Figure B2. Flight (Test) No. 1 Configuration

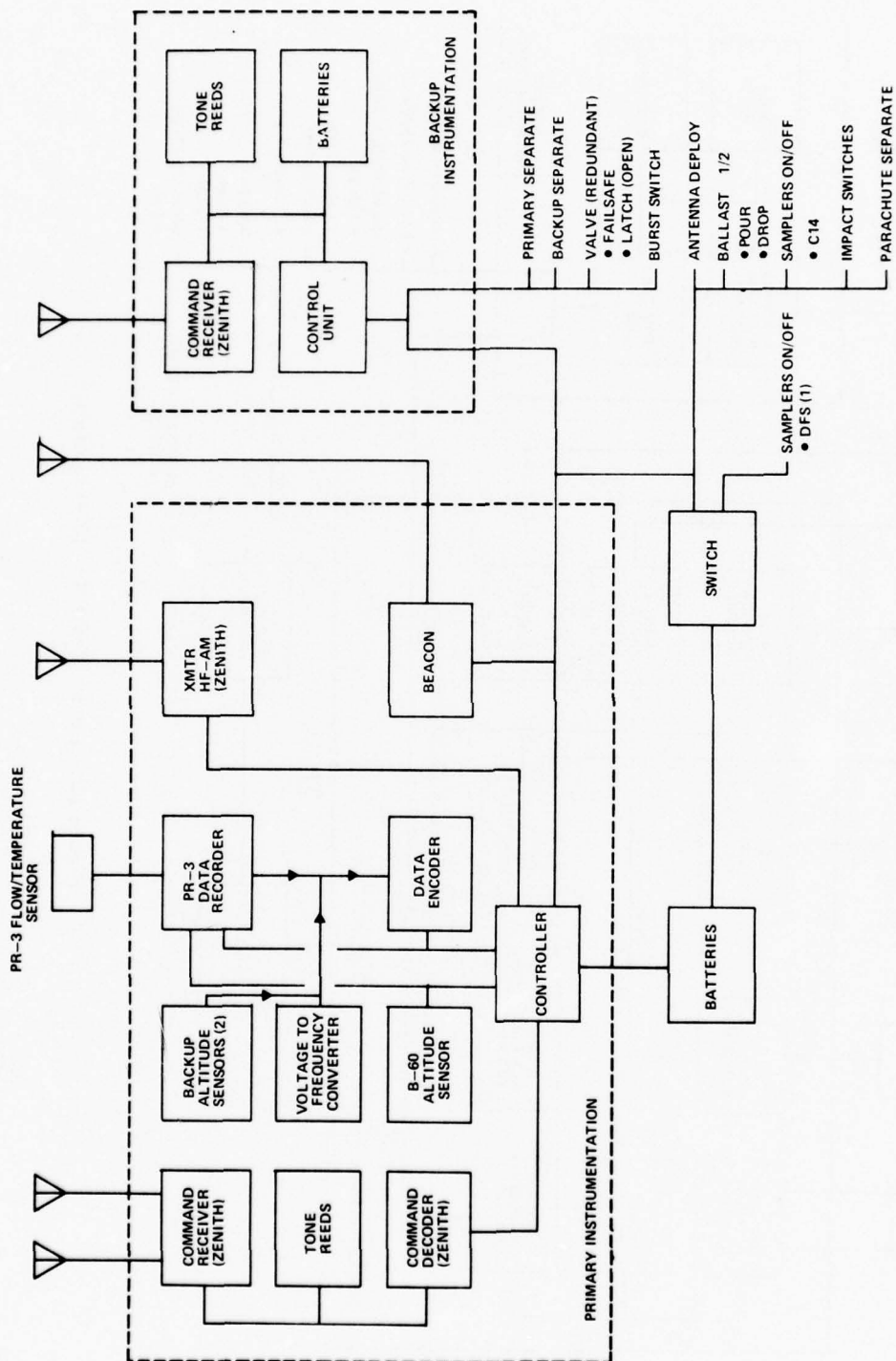


Figure B3. Flight (Test) No. 2 Configuration

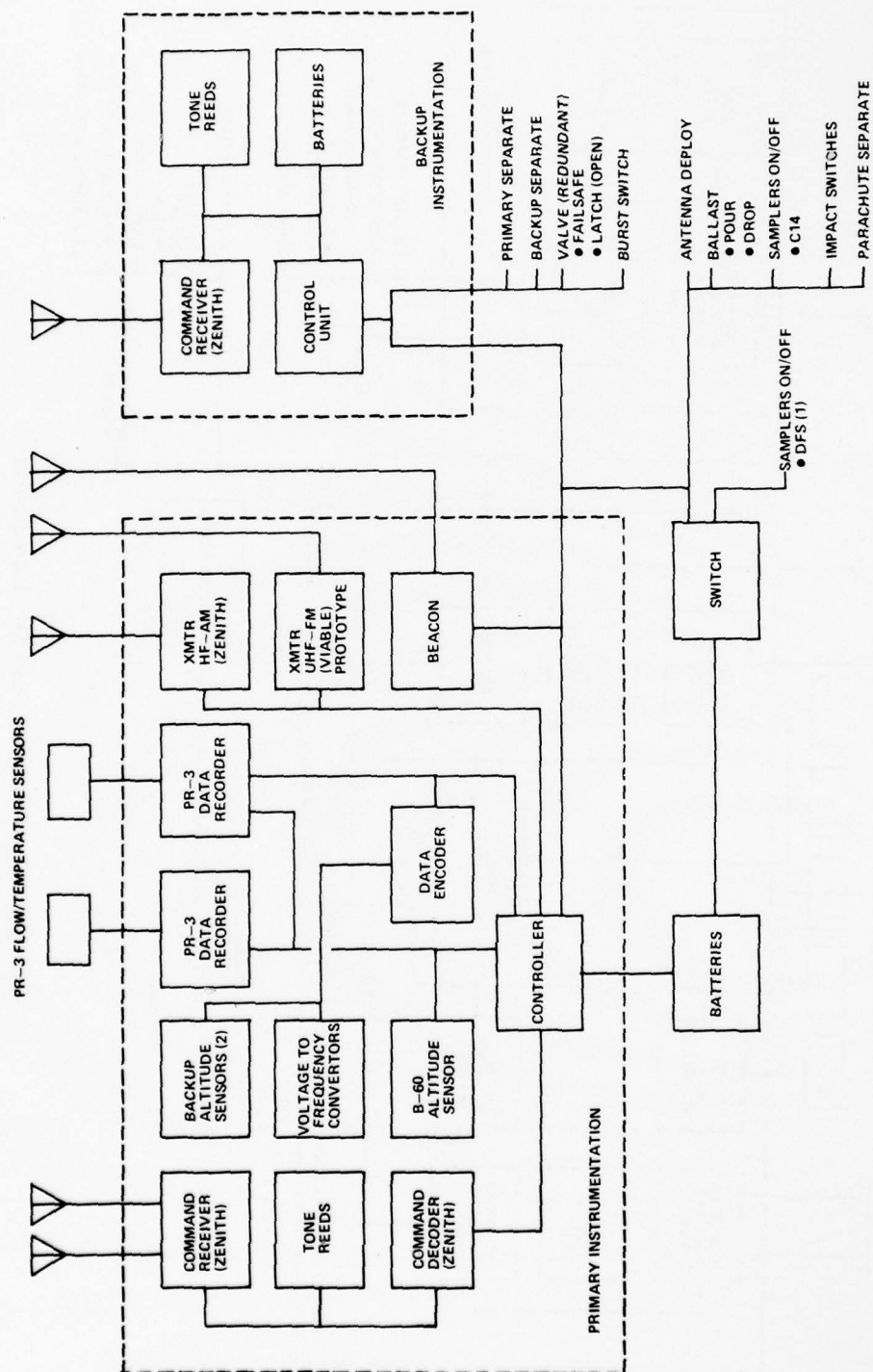


Figure B4. Flight (Test) No. 3 Configuration

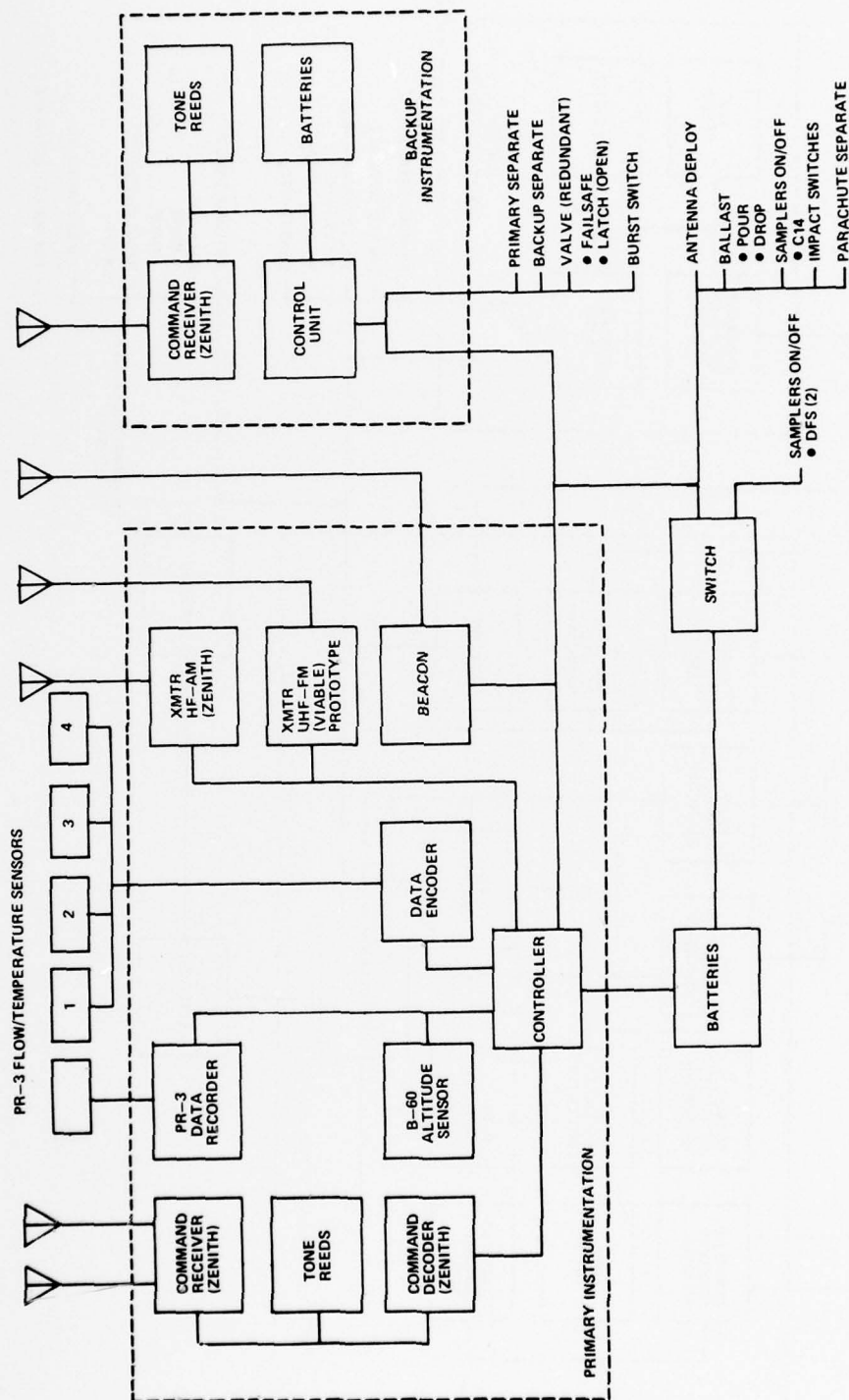


Figure B5. Flight (Test) No. 4 Configuration

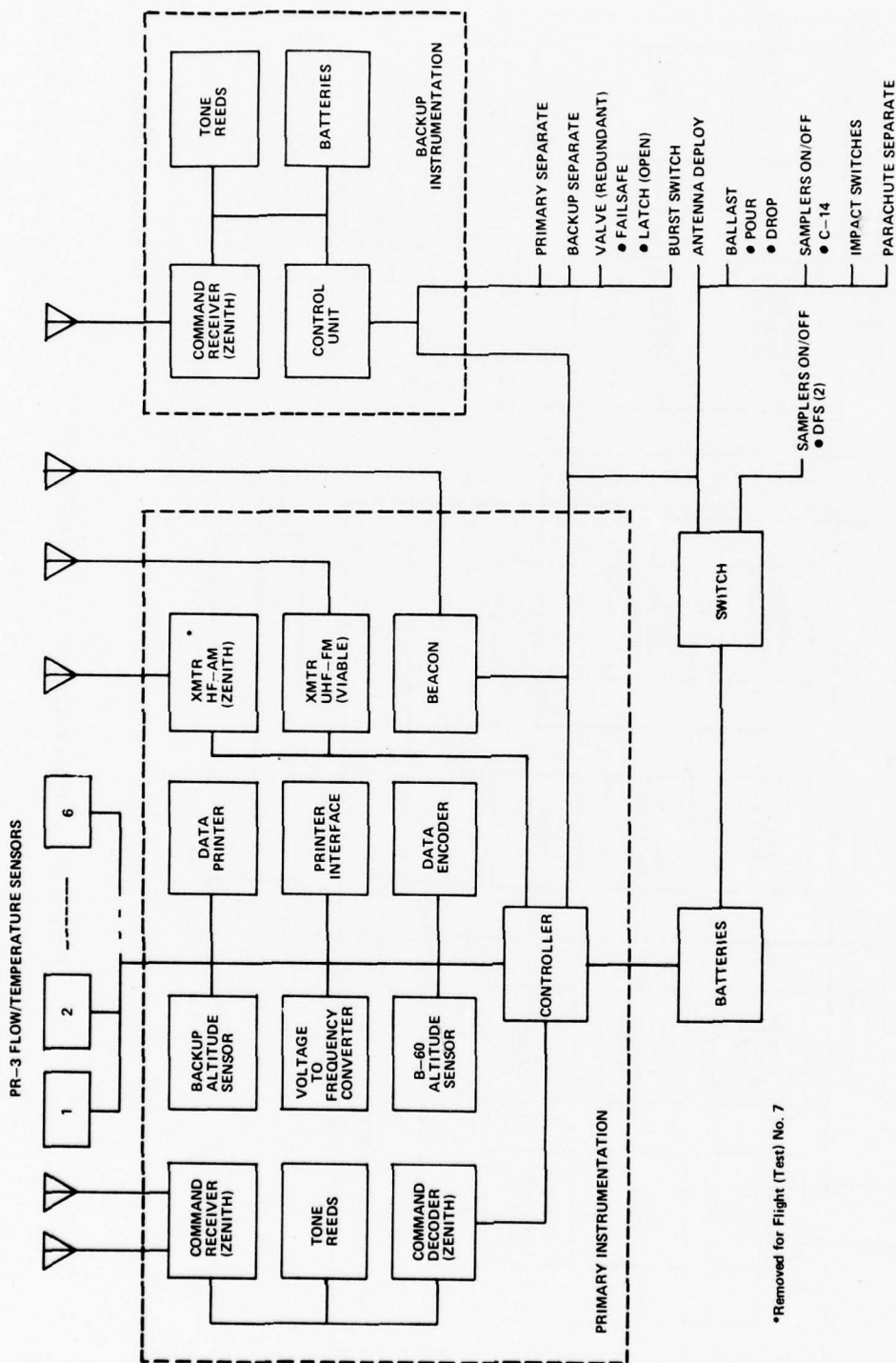


Figure B6. Flight (Test) Nos. 5, 6, and 7 Configurations

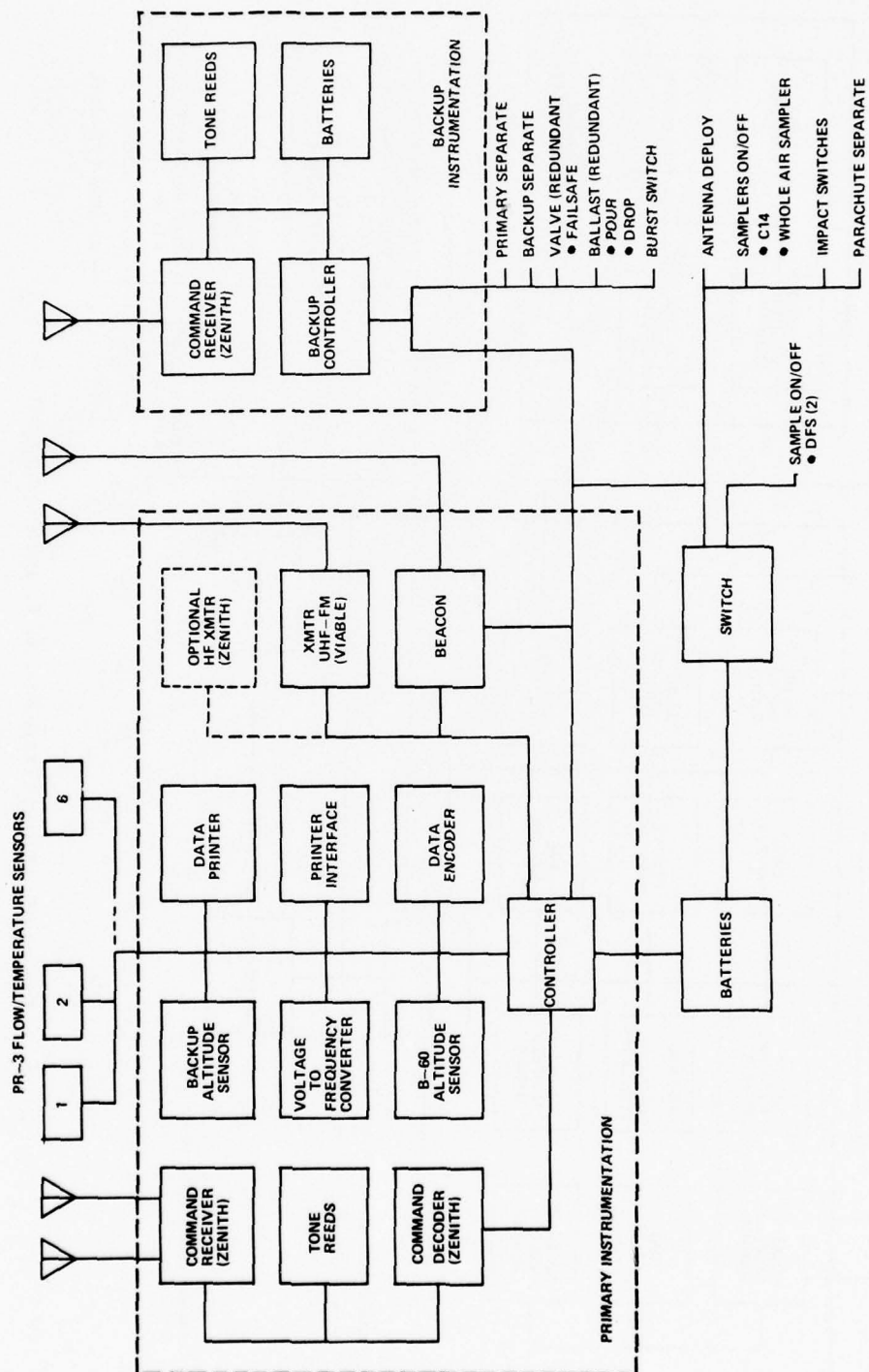


Figure B7. Flights 8 Through 21 Configurations

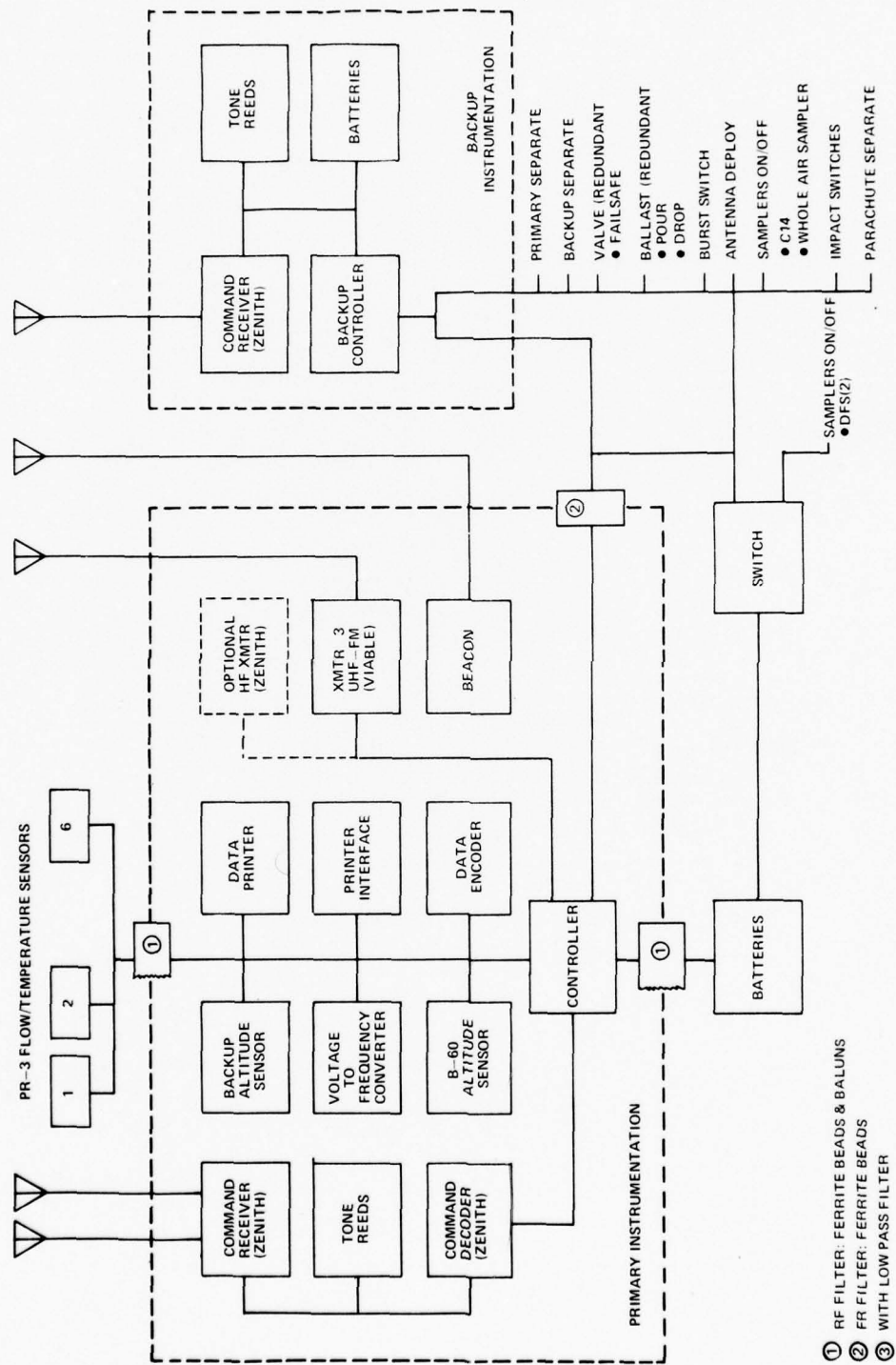


Figure B8. Flights 22, 23, and 24 Configurations

## Appendix C

### Information to Support Direct Flow Samplers

#### C1. GENERAL

The following information appeared as memos for record. Section C2 appeared in March 1975 and Section C3 appeared in November 1976.

#### C2. VOLTAGE AND CURRENT REQUIREMENTS FOR THE DFS

On 10 March a memo containing DFS current vs voltage data collected at the Holloman AFB environmental chamber was received by the author. These data were averaged, retabulated (Table C1) and graphed to facilitate its assimilation.

Figure C1 displays this family of current vs voltage curves for five altitudes. Each curve is the best straight line through the average current points for the various voltages. The vertical lines through the average current points represent the limits of the averaged current data from two DFS's.

#### C3. DISCHARGE CAPACITY OF BB-405/U BATTERIES

Eagle-Pitcher BB-405/U batteries are nominally rated at 60 Ah at the 6-hr rate. However, graphs transmitted from Eagle-Pitcher on 18 March 1975 further define the Ah rating as a function of current drain.

Pursuing an accurate estimate of available energy I plotted current capacity on various types of paper to establish a usable tool.

Table C1. Average DFS Current vs Voltage

Voltage (dc volts)	Average Current (amperes) (Altitude (k ft))				
	60	70	80	90	100
19.1	17.9	----	----	----	----
19.2	----	----	13.0	----	----
19.3	----	15.1	----	----	----
19.5	18.1	15.3	12.8	10.9	9.3
20.5	18.9	----	----	----	----
20.8	----	15.7	13.4	----	----
21.0	19.1	16.1	13.3	11.3	9.7
22.0	19.6	16.5	13.9	----	----
22.5	20.3	16.9	14.0	----	10.1
23.0	20.7	----	----	12.3	----
23.7	----	17.2	14.2	----	----
24.0	22.3	17.9	14.6	----	10.4

Plotting hours and Ah vs current for BB-405 batteries, produced virtually straight lines on log-log paper. The graph is Figure C2.

A 90 k flight of three DFS's will be used as an example.

(a) Current for one DFS at 90 kft altitude with 22.5 Vdc applied is 13 A, worst case. Three samplers powered by two parallel batteries will draw 19.5 A per battery, assuming both batteries are in identical condition. Referring to Figure C2, 19.5 A will be available for 4.1 hr which yields 79.95 Ah. Three DFS's running for 4 hr on two BB-405 packs tapped at a 22.5 Vdc require 156 Ah; the batteries can supply 159.9 Ah. The ratio of required to available Ah is 0.9756 which corresponds to a safety factor of 2.44 percent.

(b) A quicker way to obtain similar information will be demonstrated with the best case current. Under the same conditions as above, best case current is 11 A per sampler or 16.5 A per 22.5 Vdc battery. From the graph, 16.5 A will be available for 5 hours. One hr more than needed corresponds to 20 percent safety factor referenced to the battery capacitor.

(c) Check the answer in (a) using the method of (b). Current is available for 4.1 hr or 0.1 hr extra. The ratio of the extra to the available corresponds to a safety factor of 2.44 percent.

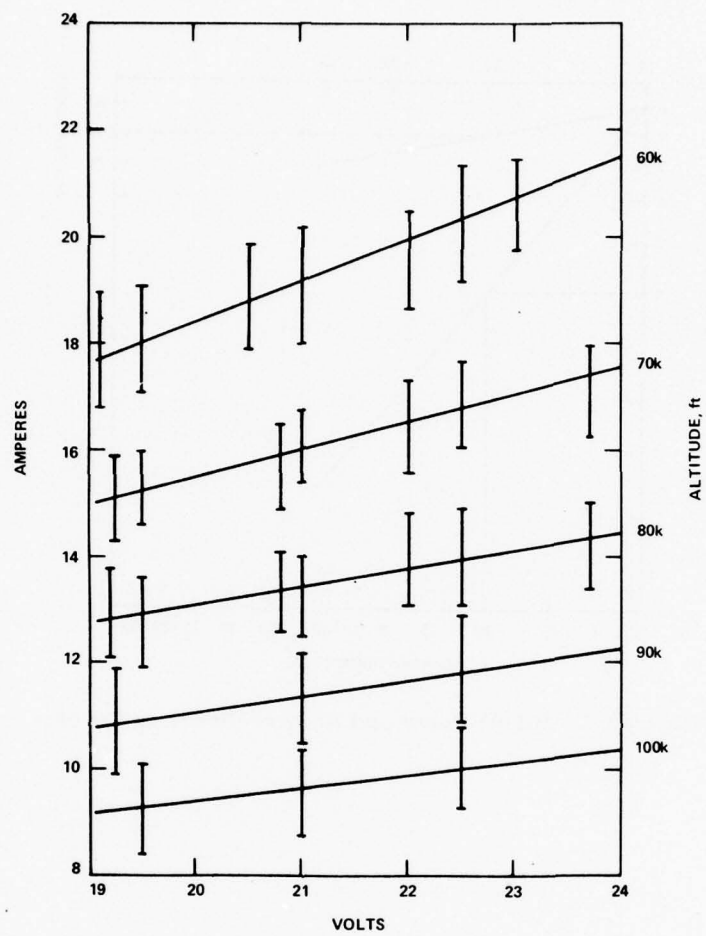


Figure C1. DFS Current vs Voltage and Altitude

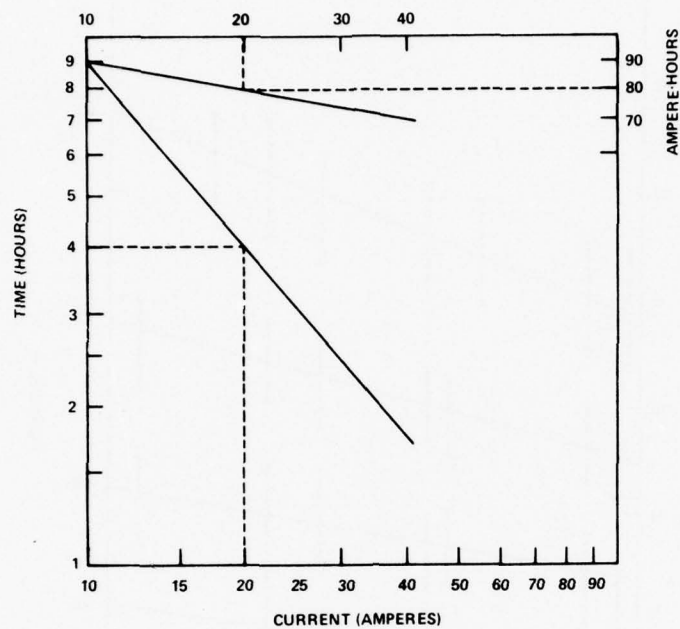


Figure C2. BB405 Hours and Ampere-Hours vs Current

## Appendix D

Progress Report: 18 July 1973

The goal of the Ash Can revision is to modify by replacement if necessary the system in such a way as to meet all present and projected aims. This will include a state of the art electronics package or packages and a universal assembly technique built around a common central package. The system electronics will be discussed first.

Studying the manuals for the sampling equipment and support equipment in conjunction with the AEC Sampling Handbook revealed that there was no system diagram of the total system or any of the three major configurations. To facilitate understanding the system, a system schematic was drawn in July 1972. The existing system consists of a Motorola VHF-FM (188.06 MHz) receiver and a six channel selector, a control unit, the B-60 altitude sensor, the SS/T 14 telemetry transmitter VHF-FM (40.35 MHz), the B-34 baro-transmitter, plus the samplers and support equipment for gathering the flow data. This system is backed up by a HF-AM (5-10 MHz) command receiver and a flight termination timer. Five of the six available channels in the primary package are used for ballast, sample on, sample off, termination and antenna drop. The backup package has gas valve failsafe, gas valve latch and termination. Note that the balloon gas valve is not controlled through the primary package. Also, altitude data is transmitted in two modes: first, a course altitude via the B-34, and second, a float altitude from the B-60 through the T-14. Utilizing the now more complete and more easily understood documentation, the system was analyzed with respect to what was wanted and

how it was led to a list of deficiencies which could be corrected through modification or addition.

These deficiencies not only pointed out some inadequacies with the in-use system, but pointed the way for the new system; therefore, a table (D1) is used to compare the two systems. However, a yes/no analysis overlooks some of the fine points involved. For example, look at the interaction of sampling and balloon altitude. The sample can only be collected between certain altitudes, for a given period of time. If the balloon begins to ascend you can valve for control in both systems; but in the in-use system, if the balloon begins to fall, you can't ballast. You can only shut off the samplers as you approach the lower boundary of the sampling zone and terminate the flight. In the new system, you can shut off the samplers, pour ballast from the ballast hopper, restart the samplers after the altitude has been corrected and continue to sample for the full period. Also, at termination by any means (timer, command, balloon burst), should the samplers be on, they will be shut off 20 sec before ballast is blown for the descent.

Once the functions of the new system were identified as outlined in the table (D1), then a choice on how to effect the equipment design was made. The excessive power requirements and weight of the present system spurred the drive for low weight and minimum power consumption which led to the CMOS CD4000A logic family. "The CD4000A series with over 60 standard parts has long passed the critical number of off-the-shelf items required of an established series. It is manufactured by at least seven companies; all have custom capability in addition to standard parts."<sup>1</sup> At this point, the new system will be outlined.

The simplest version of the system must contain several basic components: (1) a receiver for the commands, (2) a control unit to interpret the commands, sense balloon activities, and route information, (3) an encoder to process and multiplex this data, (4) a transmitter, to send data from the encoder to the ground station, (5) the samplers and flow sensors. The UTMT's, gas bottles, etc. are considered part of the sensors. The samplers and flow sensors are, of course, already in the inventory. The receiver is, to the control unit, only a set of contacts which are open or closed (grounded). The transmitter is only a port or a set of ports into which a signal or signals, can be fed. This leaves the control unit and the encoder to think about. Since we still have a choice on the output of the encoder for one or several outputs, let us look at the choices for the overall system by putting receivers and transmitters around the set of remaining units and see what we learn.

---

<sup>1</sup>Computer Design, May 1978, p 105, Kaare Karstad, "CMOS for General Purpose Logic Design".

Table D1

ITEM	SYSTEM	
	IN USE	PROTOTYPE
Balloon Functions (Main Package)	-	-
Valve Failsafe	N	Y
Ballast: Drop Slugs (15-25 lbs each)	Y	N
Pour Dust and Monitor	N	Y
Blow all ballast	N	Y
Burst Pin: Monitor	N	Y
Termination	N	Y
Impact Switch: Switch	Y	I
Termination: Timed	N	Y
Command	Y	Y
Safety Altitude and Time	N	Y
Back-up Package	-	-
Valve Failsafe	Y	I
Valve Latch	Y	Y
Termination	Y	Y
Key: N-No		
Y-Yes		
I-Improved		
Instrumentation		
Altitude Sensor	Y	I
Recorded Float Altitude	N	Y
Valve Monitor	N	Y
Ballast Monitor	N	Y
Burst Pin Monitor	N/A	Y
Homing Section: Terminate	Y	Y
(Beacon) Switchable	N	Y
Sample Protection (at Termination)	N	Y
Altitude Plus Time Turn-On	Y	N
Timed On	N	Y
Timed Off	Y	Y
Command On	Y	Y
Command Off	Y	Y
Rotate Package	Y	Y
Gas Release	Y	Y
Sampler Current in Control Unit	Y	N

Three new systems are possible:

1. HF: Using the HF receiver, selectors, and transmitters on hand at LCC. This requires one output of the encoder.

2. HF-FM: Using the HF receiver and selector as above but directing the output to go to a VHF-FM (40.35 MHz) transmitter. This also would require a single output from the encoder.

3. FM-FM: Using S-band telemetry, all data could be sent real time on up to 13 channels plus data would be received on another set of S-band channels. In this case, the encoder would not be a true analog to digital encoder but a series signal conditioning network.

The latter system (3) requires purchasing the most new equipment and that equipment is more expensive and complex than that needed for the first two systems. On these grounds, it was not considered in competition with the HF and HF-FM systems. The encoder design was now able to be finalized.

The unit labeled encoder serves several functions. As the name implies, its primary function is to serialize or multiplex several pieces of information on to one output. The information sources are analog in form and before they are multiplexed they are buffered and shaped to interface with the CMOS circuitry. After being multiplexed they are encoded to digital form and presented to the output as a stream of dots and dashes time spaced to form Morse Code. At this point a word should be said concerning the digital format of the output.

There are three major signals in the system which must be transmitted. These signals represent altitude, air flow through the PR-3, and air temperature. The altitude and flow signals are binary in form and consist of pulses that vary in frequency in proportion to the measured parameter. The temperature data is a varying voltage derived from a thermistor. Note that two out of three are binary in nature and therefore lend themselves to a digital format. The third signal is easily converted to a binary signal by incorporating the thermistor into an oscillator circuit. Now all three signals are binary where the information is contained in the frequency of the signal. The digital signal to be transmitted is derived from the binary analog signal by counting the number of pulses that occur in a carefully controlled period of time: in this case four minutes. This period was chosen based upon the large frequency variation of the B-60 from ground level to 100 kft pressure altitude. The accuracy of the data channels is always 1 count therefore by keeping the overall count above 100 the resolution can be kept better than 1 percent. As an example; over all sample altitude ranges the frequency of the signal from the PR-3 flow meter will vary from 40 Hz to 150 Hz. Therefore, in 4 seconds the encoder would count 160 to 600 counts with an accuracy of 1 count so the resolution could be 1 in 160 to 1 in 600, or 0.625 percent to 0.167 percent. The nature of this encoding by counting is such that if the count looks about right and is repeatable, then it most

probably is correct. In any event, it is very easy to verify the accuracy with an oscilloscope and the PR-3 flow sensor or a standard pulse generator.

The count that has been referenced as the end product of the encoder appears at the output as a series of dots and dashes with most significant figures first. Therefore, one count or word of the encoder message would look like

XXX    XXX    XXX    XXX

where each X is a 0 or a 1 represented by a dot or a dash respectively. This twelve bit word is a binary figure with 3 pauses added. If the pauses were eliminated or ignored then the count would be read by summing the decimal equivalent of the powers of two represented by the ones and zeros. But, there is an easier way. With the pauses in place, not only do the dots and dashes form Morse Code letters but they form an octal code where each group of these X's can vary from 0 to 7 therefore 101 001 100 010 can be read as  $(5142)_8$  which can be converted to decimal (base ten) by use of an octal to decimal conversion table  $(5142)_8 = (2658)_{10}$ . This is very easy with a little practice and once the decimal number has been obtained if the data is the flow information it can be divided by four (because the encoder sampled for 4 sec) and the actual count of the flow sensor is obtained. If the above example was valid flow data the flow rate would be proportional to 664.5 Hz. At this point it should be noted that the encoder is now assuming functions presently accomplished by the ground station equipment and personnel. The matching frequencies via Lissajous Patterns will no longer be necessary and an oscilloscope and frequency counter can be eliminated. Data can be copied by hand or recorded on magnetic tape or a strip recorder or both. This will yield permanent records from onboard and ground recording. If the above example was altitude or temperature data a calibration curve or table would convert directly from code to altitude or temperature. Because of the different signal conditioning necessary for the three types of data channels are assigned to specific functions. The first two channels are for flight altitude derived from the B-60. The first channel is used at altitudes greater than 50 kft. The resolution of these channels is at worse  $\pm 1$  percent at about 50 kft, and it improves with increasing and decreasing altitude until it is 0.1 percent at ground and 100 kft. The third channel is used to monitor the gas valve, ballast hopper and balloon burst protect circuit. The remaining channels are paired for PR-3 flow and temperature data. Channels 4, 6, 8, and 10 are for flow and channels 5, 7, 9, and 11 are for temperature. During ascent to float altitude, only the first three channels need be observed because there is no data on the remaining channels. Therefore, upon applying power to the encoder the first three channels preceded by a warning pulse will cycle continuously. As float altitude approached, a command (No. 1) can be given and the encoder message will

expand to all eleven channels (or any preset number) cycling every 3 minutes. The message containing 11 words (channels) will take about 1-1.4 min depending on the ratio of dots to dashes. Issuing command No. 1 a second time will return the encoder message to the three word format. By repeatedly issuing command No. 1, the message length can be changed as often as required. The encoder output is routed to the transmitter by way of the control unit.

The control unit is the focal point of the system. It contains a digital clock and the necessary logic circuitry and aneroid switches to ensure proper sequencing and interaction of system activities. Without issuing commands, the control unit will sequence the package through an entire mission if necessary. It will drop the antenna during ascent, turn the sampler on and off at preset times, blow ballast, terminate the flight, turn on the homing beacon and separate the package from the chute at impact. The setting of times for sample on, sample off, and terminate is accomplished via thumb wheel switches settable for 00.0 hrs to 99.9 hrs. The clock is designed so that disconnecting and reconnecting the power line resets it to 0.0 hrs. Therefore the time elapsed during checkout can be negated from the outside of the flight package simply by interrupting the power to the control unit. In the event of balloon burst, the package will be separated from the balloon and the sampler automatically turned off. When commands are issued through the HF receiver and selector, the return verification code indicating reception of the command by specific channel will be routed to the transmitter, thereby overriding the encoder for these few seconds. At termination by command, clock, or burst, an appropriate signal will be routed to the transmitter. A normal termination will cause a dashing signal to be transmitted and a balloon burst will result in a steady tone. Conspicuous by its absence in the control unit is the heavy duty open frame power relay for the samplers.

The power relay has been replaced with a solid state dc static switch which is mounted on the sampler and is activated by the control unit. This switch does not need power to hold it on. Therefore, three ends are accomplished: (1) the high current is removed from the proximity of the control logic, (2) the high current has a shorter distance to travel (less voltage drop to the blowers), and (3) there is no wasted holding power.

Before proceeding with the description of the test flights conducted to date, a few words should be said about the AR-60 altitude sensor and recorder. As noted earlier, two altitude sensors are used in the existing package. The B-34 sensor is used to follow the balloon's ascent to float altitude and the B-60 section of the AR-60 is used at float altitude. However, the entire range from ground to float altitude is within the operational limits of the B-60. The new instrument package uses the signal from a slightly modified B-60 to feed the encoder in two modes. One mode is very good up to 50 kft and the other mode is very good above 50 kft.

Therefore, one sensor supplies all the altitude data. However, the B-60 works on the ion chamber principle which degrades in quality as the altitude increases, that is, the accuracy is worst at float altitude. Research has been accomplished and procurement started on a sensor using an isotope and detector based on the energy in the particles. This sensor has its poorest accuracy (about 4 percent on the ground and its best accuracy (about 1 percent) at float altitude. The new sensor will interface directly to the new encoder and will replace the B-60 and free one more channel on the encoder. The control unit is unaffected.

The control unit and encoder previously described will function for either of the two systems now under consideration. The HF system has been flown twice and the results of these flights are given below.

The first flight (H72-73, 2 November 1972) was launched successfully; antenna drop was achieved by command the ascent appeared normal. However, at 47.8 kft after 47 min of flight, a burst indication was received by the control center and the package was on the chute. The beacon was activated and the sampler was locked off by the control unit. When the recovery crew reached the package, they noted that the impact switch had fired, and the DPS was running. At this time, the solid state dc static switch was not in use. The high blower current was being switched by a Potter-Brumfield mechanically latching relay. By correlating the times for impact, recovery, and the length of the on time from the PR-3 recorder, it was determined that the relay had latched at impact. The relay was subsequently replaced with the solid state switch designed at LCC. Although float altitude was not reached the control unit did function properly, the mechanical latching relay was proven undependable, and the control equipment was returned in perfect working order and the remaining system checked out favorably. Therefore, the flight did yield useful information. The second flight was more successful.

Launched on 27 March 1973, flight H73-17 was almost a complete success. Immediately after release, antenna drop was issued and properly activated. The system rose at about 1000 ft per min to the float altitude of 81.5 kft and in doing so, provided excellent altitude data for comparing the B-60 to two Rosemont Pressure Sensors which were on two unused encoder channels. Ballast was blown before the sampler was to come on and the expected altitude change was reflected in the B-60 and Rosemont data. When the sampler was to come on, there was no flow data on the encoder channel for the PR-3. The decision was made to assume all was OK in the sampler and continue the flight. Four hours later, prior to termination by command, the beacon (242.0 MHz) was turned on and then off by command and verified by the tracking aircraft. At termination the beacon came on and the package descended without incident. At impact the aircraft witnessed the chute impact release squibs fire. Upon the return of the package, the system was reassembled and the malfunction duplicated. The sampler ran but the UTMT did not open.

Inspection revealed the battery voltage was much lower than at launch indicating that the DFS did run for the sampling period. With a new 24 V battery pack, the sampler ran and the UTMT opened and flow data was transmitted. A cell by cell inspection of the battery pack from the flight revealed that 4 cells were bad. The voltage under the load of the DFS dropped sufficiently to prevent the UTMT from opening. This was duplicated with the new set of batteries. Although no sample was obtained the flight was very successful.

A third test flight is planned for late July 1973. This will be a reflight of the second flight system plus a new 40 MHz FM transmitter will be on board. This will enable the data to be transmitted through two down links: the HF system and the FM system.

After the test flight in late July a comparison will be made between the data available from HF telemetry and VHF-FM telemetry. Based on previous experience it is expected that interference in the VHF-FM range will be much less than that in the HF region. The configuration of the final system would be very similar to the proposed fourth test flight. The command receiver would be a modified Raven receiver/decoder and the data transmitted would be a new VHF-FM transmitter. (See four flight configuration block diagrams.) From the Mechanical point of view, the present system for assembling sampler frames onto the instrument frame is unreliable and time consuming. Because of this, it is necessary to redesign the instrumentation frame. Positive attachment, reproducible alignment and rapid assembly and disassembly is accomplished by the use of a quick disconnect clamp-on device. Also, by relocating the battery system, instrumentation, ballast, etc., the rotational requirement of the original system can be eliminated.

The new instrument storage frame has the capability of supporting one (1) to six (6) sampler frames in any sequence of combinations. The accompanying photographs demonstrate how this can be accomplished. Photo 1, shows the instrument gondola with a DFS frame in the free position. Photo 2, shows the DPS frame attached to the side of the instrument gondola for the two (2) or four (4) or six (6) frame combination. Photo 3 shows the DFS frame attached to the front for the two (2), or four (4) frame version. This prototype frame will be test flown in late July.

Future changes under consideration include choosing a tape recorder as an on board back-up should the telemetry fail, revamping the ground station and up-dating the Handbook to reflect all changes.

Incorporating the new hardware into the existing system will not be a piece by piece job. To avoid duplication of effort and numerous system changes, all new modular equipment will be built and tested. Then the existing flight system equipment will be replaced and the transformation will be complete if AEC/ARL are satisfied with the improved data collection results. Lead time on the active

components for the control unit and encoder is 35 weeks. Components were ordered late April 1973. Assembly time will be about 2 months. Until this time the old system will be used and minor maintenance changes made if necessary.

During the April series at Holloman AFB, NM, several flights were marred by faulty relays in the existing Control Units. These relays No. K 1, K 4, K 5, and K 6 were modified or replaced with sealed relays to preclude trouble from this source on future flights. These control units have been re-flown without incident.

In preparation for the new instrumentation frame interface into the system, twenty DFS frames will be made at AFCRL to replace the distorted frames now in inventory. This will eliminate the need for extensive rework to the old frame plus it will insure proper mating to the new frame attachment devices.

## Appendix E

### Instrumentation Checklist

ALTITUDE \_\_\_\_\_  
DATE STARTED \_\_\_\_\_  
FLT. NO. \_\_\_\_\_

Obtain the following items and note serial numbers:

Controller .....	_____
242 MH Beacon .....	_____
BCR 4 Receiver:  freq .....	_____
S/N .....	_____
Selector .....	_____
Transmitter .....	_____
Reed Box .....	_____
B-60 .....	_____
Rosemount .....	_____
V-F Converter .....	_____
Encoder .....	_____
Printer .....	_____
Printer Interface .....	_____

Receiver ..... \_\_\_\_\_

Reed Box ..... \_\_\_\_\_

Controller ..... \_\_\_\_\_

Initials \_\_\_\_\_

90

# Primary System Battery Check

Flight \_\_\_\_\_ Date \_\_\_\_\_

nominal cell voltage at + terminal	individual cell voltage			
	after charging		after despiking	
	no load	0.6 ohm load	no load	0.6 ohm load
<u>25 H's</u>	serial number _____			
27.0	_____	_____	_____	_____
25.5	_____	_____	_____	_____
24.0	_____	_____	_____	_____
22.5	_____	_____	_____	_____
21.0	_____	_____	_____	_____
19.5	_____	_____	_____	_____
18.0	_____	_____	_____	_____
16.5	_____	_____	_____	_____
15.0	_____	_____	_____	_____
13.5	_____	_____	_____	_____
<u>BB-405's</u>	<u>no load</u>	<u>0.3 ohm load</u>	<u>no load</u>	<u>0.3 ohm load</u>
12.0	_____	_____	_____	_____
10.5	_____	_____	_____	_____
9.0	_____	_____	_____	_____
7.5	_____	_____	_____	_____
6.0	_____	_____	_____	_____
4.5	_____	_____	_____	_____
3.0	_____	_____	_____	_____
1.5	_____	_____	_____	_____
serial number	_____		date:	_____
			time:	_____
			initials:	_____

26 Nov 75

Primary System Battery Check  
(continued)

Flight \_\_\_\_\_ Date \_\_\_\_\_

nominal cell voltage at - terminal	individual cell voltage			
	after charging		after despiking	
	no load	1.5 ohm load	no load	1.5 ohm load
<u>10 H's</u>				
-12.0	_____	_____	_____	_____
-10.5	_____	_____	_____	_____
-9.0	_____	_____	_____	_____
-7.5	_____	_____	_____	_____
-6.0	_____	_____	_____	_____
-4.5	_____	_____	_____	_____
-3.0	_____	_____	_____	_____
-1.5	_____	_____	_____	_____
serial number _____				

date: \_\_\_\_\_

time: \_\_\_\_\_

initials: \_\_\_\_\_

26 Nov 75

# Backup System Battery Check

Flight \_\_\_\_\_ Date \_\_\_\_\_

nominal cell voltage at - terminal	individual cell voltage			
	after charging		after despiking	
	no load	2.5 ohm load	no load	2.5 ohm load
<u>6 H's</u>	serial number _____			
-12.0	_____	_____	_____	_____
-10.5	_____	_____	_____	_____
-9.0	_____	_____	_____	_____
-7.5	_____	_____	_____	_____
-6.0	_____	_____	_____	_____
-4.5	_____	_____	_____	_____
-3.0	_____	_____	_____	_____
-1.5	_____	_____	_____	_____
<u>+ terminal</u>	serial number _____			
1.5	_____	_____	_____	_____
3.0	_____	_____	_____	_____
4.5	_____	_____	_____	_____
6.0	_____	_____	_____	_____
7.5	_____	_____	_____	_____
9.0	_____	_____	_____	_____
10.5	_____	_____	_____	_____
12.0	_____	_____	_____	_____

date: \_\_\_\_\_

time: \_\_\_\_\_

initials: \_\_\_\_\_

26 Nov 75

DATE \_\_\_\_\_

FLIGHT \_\_\_\_\_

DFS BATTER CHECK

SET # \_\_\_\_\_

<u>NOMINAL CELL VOLTAGE AT +</u>	<u>INDIVIDUAL CELL VOLTS NO LOAD</u>	<u>INDIVIDUAL CELL VOLTS 0.3<math>\Omega</math> LOAD</u>
24.0	_____	_____
22.5	_____	_____
21.0	_____	_____
19.5	_____	_____
18.0	_____	_____
16.5	_____	_____
15.0	_____	_____
13.5	_____	_____
12.0	_____	_____
10.5	_____	_____
9.0	_____	_____
7.5	_____	_____
6.0	_____	_____
4.5	_____	_____
3.0	_____	_____
1.5	_____	_____

Initials \_\_\_\_\_

DATE \_\_\_\_\_

FLIGHT \_\_\_\_\_

DFS BATTER CHECK

SET # \_\_\_\_\_

<u>NOMINAL CELL VOLTAGE AT +</u>	<u>INDIVIDUAL CELL VOLTS NO LOAD</u>	<u>INDIVIDUAL CELL VOLTS 0.3<math>\Omega</math> LOAD</u>
24.0	_____	_____
22.5	_____	_____
21.0	_____	_____
19.5	_____	_____
18.0	_____	_____
16.5	_____	_____
15.0	_____	_____
13.5	_____	_____
12.0	_____	_____
10.5	_____	_____
9.0	_____	_____
7.5	_____	_____
6.0	_____	_____
4.5	_____	_____
3.0	_____	_____
1.5	_____	_____

Initials \_\_\_\_\_

DATE \_\_\_\_\_

FLIGHT \_\_\_\_\_

DFS BATTER CHECK

SET # \_\_\_\_\_

<u>NOMINAL CELL VOLTAGE AT +</u>	<u>INDIVIDUAL CELL VOLTS NO LOAD</u>	<u>INDIVIDUAL CELL VOLTS 0.3<math>\Omega</math> LOAD</u>
24.0	_____	_____
22.5	_____	_____
21.0	_____	_____
19.5	_____	_____
18.0	_____	_____
16.5	_____	_____
15.0	_____	_____
13.5	_____	_____
12.0	_____	_____
10.5	_____	_____
9.0	_____	_____
7.5	_____	_____
6.0	_____	_____
4.5	_____	_____
3.0	_____	_____
1.5	_____	_____

Initials \_\_\_\_\_

# NOMINAL BAROSWITCH ACTIVATION ALTITUDES

Antenna drop (10K ft) \_\_\_\_\_ Kft  
 Burst interlock (15K ft) \_\_\_\_\_ Kft  
 Rotate package (26K ft) \_\_\_\_\_ Kft  
 Safety time interlock (45K ft) \_\_\_\_\_ Kft

## SAFETY TIME

Timer setting (2 hrs) \_\_\_\_\_ Hours  
 Use column at right if Project Officer desires a change.

## CALCULATIONS FOR TIMERS

- A. Time to float altitude is calculated using an ascent rate of 800 feet per minute from ground altitude  $A_G$  to float altitude  $A_F$

$$\text{Time to float altitude} = \frac{A_F - A_G}{48 \text{ Kft/hr.}}$$

Where  $A_F$  = float altitude (K feet) = \_\_\_\_\_

$A_G$  = ground altitude (K feet) = \_\_\_\_\_

Therefore, substituting

$$\begin{aligned} \text{Time to float altitude} &= \frac{(\quad) - (\quad)}{48} \\ &= \frac{\quad}{48} \\ &= \quad \text{hours} \end{aligned}$$

Check times with the Project Officer before proceeding.

B. Sample on Time = time before launch (0.2 hrs) + time to float + altitude  
adjust time (0.4 hrs) + time before sample (0.2 hrs)

= 0.8 hrs + time to float altitude

= 0.8 hrs + \_\_\_\_\_ hrs

SAMPLE ON TIME = \_\_\_\_\_ hours

C. Sample Off Time = Sample On time + Sample Time (see form 24)

= \_\_\_\_\_ hrs + \_\_\_\_\_ hrs

SAMPLE OFF TIME = \_\_\_\_\_ hours

D. Primary Termination = Sample off time + 2.0 hrs

= \_\_\_\_\_ hrs + 2.0 hrs

PRIMARY TERMINATION = \_\_\_\_\_ hours

E. Backup Termination = Primary Termination + 1.0 hrs

= \_\_\_\_\_ hrs + 1.0 hrs

BACKUP TERMINATION = \_\_\_\_\_ hours

HRS	0	1	2	3	4	5	6	7	8	9
0	0.00 —	3.51 —	7.03 —	10.54 —	14.06 —	17.57 —	21.09 —	24.61 —	28.13 —	31.64 —
10	35.16 —	38.68 —	42.19 —	45.71 —	49.22 —	52.74 —	56.26 —	59.77 —	63.29 1'3.3"	66.80 6'6.8"
20	70.32 1'10.3"	73.84 1'13.8"	77.35 1'17.4"	80.87 1'20.9"	84.38 1'24.4"	87.90 1'27.9"	91.42 1'31.4"	94.93 1'34.9"	98.45 1'38.5"	101.96 1'42.0"
30	105.47 1'45.5"	108.99 1'49.0"	112.51 1'52.5"	116.03 1'56.0"	119.54 1'59.5"	123.06 2'3.1"	126.58 2'6.6"	130.09 2'10.1"	133.61 2'13.6"	137.12 2'17.1"
40	140.63 2'20.6"	144.16 2'24.2"	147.67 2'27.7"	151.12 2'31.1"	154.70 2'34.7"	158.22 2'38.2"	161.74 2'41.7"	165.25 2'45.3"	168.77 2'48.8"	172.28 2'52.3"
50	175.78 2'55.8"	179.30 2'59.3"	182.81 3'2.8"	186.33 3'6.3"	189.84 3'9.8"	193.36 3'13.4"	196.87 3'16.87"	200.38 3'20.4"	203.90 3'23.9"	207.42 3'27.4"
60	210.94 3'30.9"	214.45 3'34.5"	217.97 3'38.0"	221.48 3'41.5"	225.00 3'45.0"	228.51 3'48.5"	232.03 3'52.0"	235.55 3'55.6"	239.06 3'59.1"	242.58 4'2.6"
70	246.09 4'6.1"	249.61 4'9.6"	253.12 4'13.1"	256.64 4'16.6"	260.15 4'20.2"	263.67 4'23.7"	267.19 4'27.2"	270.70 4'30.7"	274.22 4'34.2"	277.73 4'37.7"
80	281.25 4'41.3"	284.76 4'44.8"	288.28 4'48.3"	291.79 4'51.8"	295.31 4'55.3"	298.83 4'58.8"	302.34 5'2.3"	305.86 5'5.9"	309.37 5'9.4"	312.89 5'12.9"
90	316.41 5'16.4"	319.92 5'19.9"	323.44 5'23.4"	326.95 5'27.0"	330.47 5'30.5"	333.98 5'34.0"	337.50 5'37.5"	341.01 5'41.0"	344.53 5'44.5"	348.04 5'48.0"

AD-A060 062

AIR FORCE GEOPHYSICS LAB HANSCOM AFB MASS  
ABOUT THE DEVELOPMENT OF A SECOND GENERATION ATMOSPHERIC SAMPLE--ETC(U)  
MAR 78 R H CORDELLA  
AFGL-TR-78-0065

F/G 4/1

UNCLASSIFIED

NL

2 OF 3  
AD  
A0 60062



SECTION ONE:

BENCH CHECK OF CONTROLLER

- 1-1. Remove controller from its case and visually inspect for loose components, broken wires, bent pins etc. Check all fuses. \_\_\_\_\_
- 1-2. Set Safety Switch to "5" and set baroswitches.  
Actual altitudes: Antenna Drop \_\_\_\_\_ Kft  
burst \_\_\_\_\_ Kft  
rotate \_\_\_\_\_ Kft  
safety \_\_\_\_\_ Kft
- 1-3. Set all times to 99.9 \_\_\_\_\_
- 1-4. Connect Power Cable to J-1  
Connect Command Simulator to J-2  
Connect Test Box J-31 to J-3  
Reset all Test Box Circuit Breakers \_\_\_\_\_
- 1-5. Apply power to Controller  
Indications:  
Valve Closed light-ON  
Sample Off Light-ON ( $\approx$  6 Osec.)  
Skinner Closed light-ON ( $\approx$  6 Osec.) \_\_\_\_\_
- 1-6. Using a VOM do a zero voltage check and then a resistance check on the primary separation squib port. \_\_\_\_\_
- 1-7. Depress Command 1  
Indications:  
No change in indications \_\_\_\_\_
- 1-8. Depress Command 2  
Indications:  
Beacon light-ON (remains on after command released) \_\_\_\_\_
- 1-9. Depress Command 3  
Indications:  
Blow Ballast breaker tripped.  
Blow Ballast light-ON (OFF when command released)  
Reset breaker \_\_\_\_\_
- 1-10. Depress Command 4  
Indications:  
Antenna drop breaker tripped  
Antenna drop light-ON (OFF when command released)  
Beacon light-OFF  
Reset breaker \_\_\_\_\_

- 1-11. Depress Command 5  
Indications:  
ASV light-ON  
2 Wire Skinner light-ON (OFF when command released)  
3 Wire Skinner light-ON (OFF when command released)  
HCS ON light-ON (OFF when command released) \_\_\_\_\_
- 1-12. Depress Command 6  
Indications:  
ASV light OFF  
HCS OFF light ON (for = 70 seconds after released)  
Skinner closed lights ON (for = 70 seconds after  
command released) \_\_\_\_\_
- 1-13. Depress Command 7  
Indications:  
Valve open light ON (when command depressed)  
Valve closed light OFF (when command depressed)  
Valve open light-OFF (when command released)  
Valve closed light-ON (when command released) \_\_\_\_\_
- 1-14. Depress Command 8  
Indications:  
Pour ballast light-ON (OFF when command released) \_\_\_\_\_
- 1-15. Depress Command 9 for 5 seconds  
Indications:  
Valve closed light-OFF  
Valve open light-ON  
HCS Lock light-ON  
HCS OFF light-ON  
Skinner closed light-ON  
After Approximately 5 seconds:  
Beacon light-ON  
After Approximately 70 seconds:  
Sample OFF light-OFF  
Skinner closed light-OFF  
After Approximately 32 seconds:  
Main Separate breaker-tripped  
Main Separate light-ON  
Gas Release light-ON  
Blow Ballast light-ON  
After Approximately 64 seconds:  
Main Separate light-OFF  
Valve Closed light-ON  
Valve Open light-OFF  
Sample Lock light-OFF  
Gas Release light-OFF  
Blow Ballast light-OFF \_\_\_\_\_

- 1-16. Depress Command 5  
Indication:  
Sample should NOT come ON \_\_\_\_\_
- 1-17. Remove power from Controller  
Reset all test box circuit breakers  
Set safety time switch to predetermined hours  
and record setting \_\_\_\_\_ hours and elapsed time  
for accelerated mode \_\_\_\_\_ seconds. \_\_\_\_\_
- 1-18. Apply power to controller and, after the sampler OFF  
pulse has passed, connect jumper from  $V_{DD}$  to test key.  
Indication:  
After the number of seconds recorded in 1-16 plus  
4 seconds have elapsed the termination sequence begins  
and runs as usual. \_\_\_\_\_
- 1-19. Remove power from controller. Remove jumper from test key  
Reset test box circuit breakers.  
Set time switches to previously calculated values  
and look up accelerated times.
- |                      |   |   |                |
|----------------------|---|---|----------------|
| Sample On _____ hrs  | : | : | On _____ sec.  |
| Sample Off _____ hrs | : | : | Off _____ sec. |
| Terminate _____ hrs  | : | : | T _____ sec.   |
- On Board 1:  
Set safety switch to 5  
Place scope probe on resistor R 31 (200K $\Omega$ ) to note 0.35  
second pulse.  
Probe should be on side of R 31 nearest board connection. \_\_\_\_\_
- 1-20. Apply power to controller. After OFF light are  
extinguished, connect test key jumper.  
Indications:  
After approximately ON seconds:  
Sample on light ON (momentary)  
Skinner open light-ON (momentary)  
After approximately OFF seconds:  
Sample off light ON (momentary)  
Skinner closed light ON (momentary)  
After approximately T seconds:  
A pulse will be noted on the scope \_\_\_\_\_
- 1-21. Remove power from controller. Remove scope probe.  
Set all time switches to 99.9 hours  
Remove jumper from  $V_{dd}$  to test key  
Connect jumper from C to NO on antenna  
drop baroswitches (S1) \_\_\_\_\_

- 1-22. Place burst switch in OFF (Open) position

Apply power to controller

Indications:

Valve closed light-ON  
Sample OFF light-ON ( $\approx$  70 sec.)  
Skinner closed light-ON ( $\approx$  70 sec.)  
Antenna drop breaker-Tripped  
Antenna drop light-ON

---

- 1-23. Remove power from controller  
Remove jumper from S1

ONLY AT INITIAL CONSTRUCTION: Use the set screw on S1 to simulate ascending and decending past 10K feet to check out the impact circuit.

---

- 1-24. Place jumper NC to C of S2  
Apply power  
Set burst switch on test box to ON position

Indications:

Main Separate breaker-tripped  
Main separate light-ON  
Valve closed light-OFF  
Valve open light-ON  
Sample lock light-ON  
Sample off light-ON  
Skinner closed light-ON  
Gas release light-ON  
Blow ballast breaker-tripped  
Blow ballast light-ON

After Approximately 5 seconds:  
Beacon light-ON

After Approximately 70 seconds:  
Sample off light-OFF  
Skinner closed light-OFF

After Approximately 64 seconds  
Valve closed light-ON  
Valve open light-OFF  
Sample lock light-OFF

---

- 1-25. Turn power off for at least 30 seconds. Open the burst switch. Turn power on. Momentarily depress command 10 button. Close burst switch.  
Indication:

There should be no change as the burst switch is now latched out of the circuit.

---

- 1-26. Using a frequency counter check the output of the oscillator which is used to drive the FM Transmitter. Test point 2, on board 2, is available without removing the board.

Record the frequency \_\_\_\_\_ Hz.  
Remove the counter probe

\_\_\_\_\_

- 1-27. Remove power from controller  
Reset all test box circuit breakers  
Remove all cables from controller  
Remove jumper from baroswitch

\_\_\_\_\_

- 1-28. Install controller in instrument frame

\_\_\_\_\_

SECTION TWO:

BENCH CHECK OF ENCODER

- 2-1. Assemble test equipment: encoder test set (signal generator and two cables), power supply and, strip chart recorder. \_\_\_\_\_
- 2-2. Remove encoder from its case. Inspect it for loose components, bent pins, foreign matter. \_\_\_\_\_
- 2-3. Set power supply for 13V and turn it off. Attach power leads to signal generator. Connect encoder to signal generator using Cable I.  
Place all flow channel switches in OFF (down) position.  
Set "Hertz" selection dial at 30.  
Sonalert may be on or off to suit operator if the chart recorder is used.  
If you want to see the messages, monitor the encoder output by connecting a chart recorder on the appropriate binding posts. \_\_\_\_\_
- 2-4. Turn on power supply.  
Result:  
Encoder begins in short cycle: i.e., the first three channels (B-60, housekeeping, Rosemount) are repeated over and over. The codes will be approximately:  
channel 1 SWUD (0314)  
2 SSSS (0000)  
4 DSSS (4000)  
Remember that a digital system has a 1 bit resolution; therefore, the code may vary in the least significant letter. \_\_\_\_\_
- 2-5. Depress the valve reply button until the second channel code begins.  
Result:  
Code on channels one and three unaffected. Code on channel 2 changes to DSSS for one message. \_\_\_\_\_
- 2-6. Depress ballast reply button until the second channel code begins.  
Result:  
Code on channel two changes to RSSS for one message. \_\_\_\_\_
- 2-7. Depress burst pin reply button until the second channel code begins.  
Result:  
Code on channel two changes to USSS for one message. \_\_\_\_\_

2-8. Depress command 1 button momentarily.

Result:

Encoder restarts the message and will continue to long cycle. The words for channels greater than three are sets of flow (even numbered channels) and temperature (odd numbered channels) data. All flow channels will have codes of SSSS or SSSU and the temperature channels will have a code where the first letter of the word, corresponds to the number of the data set' i.e.,

set	channels	temperature code
1	4, 5	U --- (1 --- )
2	6, 7	R --- (2 --- )
3	8, 9	W --- (3 --- )
4	10, 11	D --- (4 --- )
5	12, 13	K --- (5 --- )
6	14, 15	G --- (6 --- )

2-9. Engage the first flow channel (work #4) with flow channel switch #1.

Result:

Code of SUOS (0170) is on channel 4 every message. The least significant letter (on the right) may be a U or an R.

Disengage flow channel #1.

2-10. Check remaining channels using same method outlined in 2-9. Use reset button on the encoder to expedite the procedure if desired.

flow channel:	2	_____
	3	_____
	4	_____
	5	_____
	6	_____

2-11. If desired 2-9 and 2-10 can be repeated for 60 Hz and/or 90Hz. The codes are SWGS (0360) and SKKS (0550) respectively.

2-12. Turn off power supply and disconnect the test set from the encoder.

2-13. Install encoder in package

SECTION THREE:

CHECKOUT OF PRIMARY PACKAGE

- 3-1. Install controller in instrumentation frame  
Connect J-11 on package to J-1 on controller  
Connect Command Simulator to J-2 on controller  
Connect J-31 on package to J-3 on controller  
Connect J04 to J03 on filter  
Connect J-33 on package to J-34 on Test Box  
Connect J-12 on package to Power Cable  
Connect J01 to J02 on filter  
Disconnect power connectors from beacon, FM transmitter,  
printer interface, B-60 and Rosemount  
Connect J-51 to J-50 on controller  
Connect beeper box to AM transmitter connector
- 3-2. Reset all circuit breakers  
Apply power to package  
Indications:  
Valve closed light-ON  
HCS off light ON (70 sec.)  
Skinner closed lights ON (70 sec.)
- 3-3. Depress Command 1  
Indications:  
No change in indications
- 3-4. Depress Command 2  
Indications:  
No change in indications
- 3-5. Depress Command 3  
Indications:  
Blow ballast breaker tripped  
Blow ballast light-ON (OFF when command released)
- 3-6. Depress Command 4  
Indications:  
Antenna drop breaker tripped  
Antenna drop light-ON (OFF when command released)
- 3-7. Depress Command 5  
Indications:  
HCS On light ON (OFF when command released)  
Skinner Open light-ON (OFF when command released)  
ASV light-ON
- 3-8. Depress Command 6  
Indications:  
HCS Off light-ON  
Skinner Closed lights-ON  
For  $\approx$  70 seconds after command released  
ASV light-OFF

- 3-9. Depress Command 7  
Indications:  
Valve Open light-ON  
Valve Closed light OFF when command depressed  
Valve Open light-OFF  
Valve Closed light-ON when command released \_\_\_\_\_
- 3-10. Depress Command 8  
Indications:  
Pour Ballast light-ON (OFF when command released) \_\_\_\_\_
- 3-11. Reset all circuit breakers  
Depress Command 9 for 5 seconds  
Indications:  
Valve Closed light-OFF  
Valve Open light-ON  
Sample Lock light-ON, dashing for  $\approx$  one minute  
Skinner Closed light-ON  
After Approximately 70 seconds  
Sample OFF light-OFF  
Skinner Closed light-OFF  
After Approximately 32 seconds  
Main Separate breaker-Tripped  
Main Separate light-ON  
Gas Release light-ON  
Blow Ballast breaker-Tripped  
Blow Ballast light-ON  
After Approximately 64 seconds  
Main Separate light-OFF  
Valve Closed light-ON  
Valve Open light-OFF  
Sample Lock light-OFF  
Gas Release light-OFF  
Blow Ballast light-OFF \_\_\_\_\_
- 3-12. Depress Command 5  
Indications:  
No change in indications \_\_\_\_\_
- 3-13. Remove Power from package  
Reset all Test Box circuit breakers \_\_\_\_\_
- 3-14. Install AM transmitter in package (optional)  
Connect J-52 on Package to transmitter  
Connect J-41 on package to J-4 on controller  
Connect J-414 on package to J-415 on encoder \_\_\_\_\_

- 3-15. Apply power to package  
Indications:  
Beeper Box emits a steady tone for approximately 4 seconds. Then 4 morse code "S", pause, 4 morse code "S", pause, 4 morse code "S", and back to 4 second warning tone to indicate start of cycle. (This is called "short mode").
- 3-16. Depress Command 1  
Indications:  
Beeper Box emits a warning tone for as long as the command is depressed.  
When command is released, encoder steps through a random number of information channels until encoder key is received from the control unit. When encoder key is received, encoder will cycle back to warning tone, then step through 15 information channels. (This is called "Long mode").
- 3-17. Depress the Reset Button on top of the Encoder  
Indications:  
Encoder will cycle to the warning tone.
- 3-18. Disconnect J-414 from Encoder for one minute  
Indications:  
When Power is restored Encoder will be in short mode
- 3-19. Depress Command 1  
Indications:  
Encoder will go into long mode
- 3-20. Depress Command 1  
Indications:  
Encoder will go into short cycle
- 3-21. Remove power from the package  
Connect J-42 to the B-60. Energize package.  
Indications:  
The code on Encoder channel one will change from SSSS to a combination representative of the altitude at which the check is being performed. Check altitude in the dictionary. No other channel will change.
- 3-22. Connect J-46 to the Rosemount altitude sensor and J-44 to the voltage to frequency converter.  
Indications:  
If the Rosemount sensor is of the range 0-16 PSIA. A code other than SSSS will appear on Encoder channel three. Check this in the dictionary.

- 3-23. Remove power from the package and connect J-412 to the data printer interface box. Reapply power. While the transmitter gives the 4 second tone the printer will skip a line. The printer will record each data word plus a time code as the transmitter begins to transmit.
- 3-24. Press and hold command 7 until indication is confirmed.  
Indications:  
Test Box will indicate valve open voltage is applied and will return a reply signal to the controller and encoder so that "DSSS" is transmitted on channel two and "DSSS" is printed by the data recorder.
- 3-25. Press and hold Command 8 until indication is confirmed.  
Indication:  
Test Box will indicate pour ballast and will return a reply signal to the Encoder so that "RSS" is transmitted on channel two and "RSSS" is printed.
- 3-26. Place burst switch simulator on Test Box in the set (continuity) position.  
Indication:  
The Encoder will signal "USSS" on channel two via the transmitter and the data recorder will print "USSS"
- 3-27. Reset the Burst Switch Simulator.
- 3-28. Remove Power. Remove command simulator. Connect J-21 to J-2. Connect J-26 to the receiver, J-25 to the reed box and J-22, J-23, J-24 to the selector. Connect an antenna to the receiver.
- 3-29. Reapply power and using the command test set issue commands 1 through 9, verify replys and verify indications as in steps 3-3 through 3-12.
- |           |           |           |
|-----------|-----------|-----------|
| Frequency | _____ KHz | _____ KHz |
| 1         | _____     | 6         |
| 2         | _____     | 7         |
| 3         | _____     | 8         |
| 4         | _____     | 9         |
| 5         | _____     |           |
- 3-30. Remove power. Connect Wattmeter to FMT-1A feed through on Package. Connect J-53 to the transmitter. Turn on FM receiver.
- 3-31. Reapply power to the instrumentation. Tune the FM receiver to the FM transmitter frequency. The FM and AM transmissions should be identical. The Wattmeter should indicate about 10 watts.
- 3-32. Remove Power.

3-33. Disconnect J-53 from the FM transmitter. Remove Wattmeter.  
Attach data cable to J-48 and using the encoder signal  
generator check the continuity of the cable and numbering of  
the J-42X connectors. \_\_\_\_\_

3-34. Remove power. \_\_\_\_\_

SECTION FOUR:

BENCH CHECK BACKUP CONTROLLER AND BACKUP PACKAGE

- 4-1. Attach battery/receiver cable to power supplies or batteries.

WHT	-12v
BLK	GND
RED	+12v
GRN	+12v if S-68 SQUIBS are used.

- 4-2. Attach command simulator (CS-2) to the battery/receiver cable.

- 4-3. Connect the battery/receiver cable to the backup controller.

- 4-4. With the start plug out, connect the system interface cable to the backup controller and to the test box J-61, J-100 and J-101. J-62 is not connected at this time.

- 4-5. Set the time to termination to 99.9 hours and connect the start plug.

Indication:

No lamp will come on because J-62 is not connected.

- 4-6. Using a VOM do a zero voltage check and then a resistance check on the secondary separation squib port.

- 4-7. Press command three on the command simulator. Release command three.

Indication:

While the button is depressed the lamp indicating pour Ballast will be lit.

- 4-8. Press command two on the command simulator. Release command two.

Indication:

When the button is depressed the lamp indicating the application of valve opening voltage will be lit. When the button is released the lamp indicating what valve closing voltage is applied will be lit for about 30 seconds. This gives the valve time to close using the batteries in the backup package. The extinguishing of the lamp indicates that control of the valve has switched back to the primary controller but J-62 is not connected. So the lamp which would normally be lit (indicating closing voltage) is not lit.

- 4-9. Press command one for 5 seconds on the command simulator.  
Release command one.

Indication:

The lamp indicating application of the valve opening voltage will come on immediately.

At about 32 seconds the secondary termination light comes on and ballast blow lamp will illuminate.

At about 64 seconds the ballast and separation lamps will extinguish and the lamp indicating valve closing voltage will light.

At about 95 seconds the valve light will go out.

- 4-10. Remove power from the backup controller. Set the time select switch for the hours from launch that backup time will terminate the flight. TIME \_\_\_\_\_ HRS

- 4-11. Open the backup controller and place a jumper from Vdd to the clock accelerate test point. Look up the elapsed time corresponding to the time set in. TIME \_\_\_\_\_ MIN \_\_\_\_\_ SEC

- 4-12. Place scope probe on resistor R1 (200K $\Omega$ )  
Using a stop watch time the accelerated clock from the application of power to the positive pulse on the scope  
MIN \_\_\_\_\_ SEC

- 4-13. Remove power

- 4-14. Remove jumper between Vdd and clock accelerate of backup controller. Remove scope probe.

- 4-15. Check receiver/selector with BCTS 3A.

SECTION FIVE:

CHECKOUT OF INTEGRATED SYSTEM

- 5-1. Check receiver and reeds using BCTS-3A  
Install components in back-up package  
Connect back-up package components \_\_\_\_\_
- 5-2. Insure all primary instrumentation components are connected. \_\_\_\_\_
- 5-3. Connect system interface cable between primary instrumentation  
and back-up package  
Connect Test Box into system interface cable.  
Connect Beeper Box to AM Output of primary instrumentation.  
Connect Wattmeter to FM Output of primary instrumentation \_\_\_\_\_
- 5-4. Connect power cable between primary instrumentation and  
instrumentation and battery box.  
Install back-up package start plug. \_\_\_\_\_
- 5-5. Using BCTS-3A, Command 7  
Indications:  
Valve open light ON (When Command Depressed).  
Valve closed light OFF (When Command Depressed).  
Valve open light-OFF (When Command Released).  
Valve closed light-ON (When Command Released). \_\_\_\_\_
- 5-6. Using BCTS-3A, Command 8  
Indications:  
Pour ballast light-ON (OFF when Command Released). \_\_\_\_\_
- 5-7. Using BCTS-3A, Command 9  
Indications:  
Valve open light-ON  
Valve closed light-OFF  
After Approximately 32 seconds:  
Main separate breaker Tripped  
Main separate light-ON  
Blow ballast breaker-Tripped  
Blow ballast light-ON  
After Approximately 64 seconds:  
Main separate light-OFF  
Valve closed light ON  
Valve open light OFF  
Blow ballast light-OFF \_\_\_\_\_
- 5-8. Remove power from primary and back-up package.  
Connect high current switch to control cable.  
Connect high current switch to test motor  
Connect high current switch to DFS batteries.  
Connect CS-1 to J-2 on Controller  
Apply power to primary and back-up packages. \_\_\_\_\_

----- NOTE -----

In the following step the motor must not run for more than 2 minutes to prevent damage to equipment. Also, each section of each high current switch must be checked.

- 5-9. Using CS-1, command 5 and hold until motor comes on. As soon as motor reaches speed command 6 to shut down. (Note: In event motor will not respond to command 6, disconnect DFS battery pack to prevent damage). \_\_\_\_\_
- 5-10. Using CS-1, command 5  
command 9 and insure termination sequence shuts down motor.  
command 5 and insure motor cannot be re-started after initiation of termination sequence. \_\_\_\_\_
- 5-11. Disconnect high current switch from DFS battery package.  
Disconnect high current switch from control cable.  
Reset all est ox circuit breakers.  
Apply Power to primary and back-up packages. \_\_\_\_\_
- 5-12. Using BCTS-3A non-sequenced, Command 2  
Indications:  
Valve open light-ON  
Valve closed light-OFF when command depressed  
Valve open light-OFF  
Valve closed light-ON when command released \_\_\_\_\_
- 5-13. Using BCTS-3A non-sequenced, command 3  
Indications:  
Pour ballast light-ON (OFF when CMD released) \_\_\_\_\_
- 5-14. Using BCTS-3A, non-sequenced command 1  
Indications:  
Valve open light-ON  
Valve closed light-OFF  
After Approximately 32 seconds:  
Backup separate breaker-tripped  
Backup separate light-ON  
Blow ballast breaker-Tripped  
Blow ballast light-ON  
After Approximately 64 seconds:  
Backup separate light-OFF  
Valve open light-OFF  
Valve closed light-ON  
Blow ballast light-OFF \_\_\_\_\_
- 5-15. Remove power from primary and back-up packages. \_\_\_\_\_
- 5-16. If time permits repeat Steps 5-3 thru 5-7 using control center transmitter. \_\_\_\_\_

- 5-17. Connect impact circuit test box between J-39 and J-310 after connecting J-34 to primary package. Apply power to packages.

Indication:

Green lamp lights indicating squib is grounded. \_\_\_\_\_

- 5-18. Depress switches 1 through 4 (simulating impact switches).

Indication:

Should have no effect. \_\_\_\_\_

~~~~~ WARNING ~~~~~

This next step simulates ascent past antenna drop aneroid altitude and it will energize the antenna drop squib circuit.

- 5-19. Depress arm button (momentarily)

Indication:

Amber light ON momentarily (Circuit now Armed)  
Green light remains ON \_\_\_\_\_

- 5-20. Depress any switch 1 through 4 (simulating impact switches)

Indication:

Will trip the circuit breaker simulating the squib.  
Red light-ON  
Green light-OFF \_\_\_\_\_

- 5-21. Remove power from primary and back-up packages.  
Disconnect impact circuit test box. \_\_\_\_\_

- 5-22. Conduct a valve check through the balloon. Code \_\_\_\_\_.

- 5-23. Check burst pin and code \_\_\_\_\_.

- 5-24. At the parachute apex perform zero voltage and zero resistance checks on the primary separation squib port \_\_\_\_\_  
and on the secondary separation squib port \_\_\_\_\_.

SECTION SIX

FINAL PREPARATIONS

6-1. Set or verify the following flight data:

Primary package:  
SAMPLE ON: \_\_\_\_\_  
SAMPLE OFF: \_\_\_\_\_  
TERMINATE: \_\_\_\_\_  
SAFETY SWITCH: \_\_\_\_\_  
Back-up package:  
TERMINATE: \_\_\_\_\_

- 6-2. Check all cable connections in primary and back-up packages.  
Verify all components secure in primary and back-up packages.  
Verify back-up batteries securely connected and held in place.  
Verify system batteries securely connected and held in place.  
Check all cable connections and associated hardware for  
security on complete rack.  
Insure rack is prepared for movement to flight line. \_\_\_\_\_
- 6-3. Put a new paper refill in the printer \_\_\_\_\_
- 6-4. Verify all items on this checklist have been completed and  
initialed to indicate completeness. \_\_\_\_\_
- 6-5. Attach ground strap between instrumentation frame  
and gondola. \_\_\_\_\_

## Appendix F

### Flow Rate Program

#### F1. GENERAL

This program produces a dictionary to relate flow rates to every code combination available from the encoder. It has no input per se because the relationship between the flow rate and the events counted by the data counter is purely mathematical and is generated in the program.

##### F1.1 The Algorithm

The counts are four times the frequency output by the PR-3 flow sensor because the frequency is doubled and sampled for two seconds. Therefore

$$\text{Count} = \text{frequency} \left( \frac{\text{events}}{\text{second}} \right) \times 2 \times 2 \text{ sec} = \text{events} \times 4 .$$

See Reference 1, Section 6.4 for a block diagram and Reference 14 for its implementation.

##### F1.2 The Output

Sixteen pages of tables, 256 words per page, comprise the computer output. Both data printers (flight and ground) record the twelve bit data word in a four letter code where each letter represents three bits. Therefore, should the flow rate be represented by SRKG, the speed of the flow sensor is 43.50 Hz. This figure is used with the sensor calibration to ascertain the flow rate as cubic feet per minute.

A complete copy of the computer program follows. The dictionary is printed in an  $8 \times 10\frac{1}{2}$  in. format to facilitate placement in a ring binder. It is valid until the sensor or encoder is changed.

0000 0000 0000 0000 0000 0000 0000 0000 0000 0000

[illegible]

| Year | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | 2055 | 2056 | 2057 | 2058 | 2059 | 2060 | 2061 | 2062 | 2063 | 2064 | 2065 | 2066 | 2067 | 2068 | 2069 | 2070 | 2071 | 2072 | 2073 | 2074 | 2075 | 2076 | 2077 | 2078 | 2079 | 2080 | 2081 | 2082 | 2083 | 2084 | 2085 | 2086 | 2087 | 2088 | 2089 | 2090 | 2091 | 2092 | 2093 | 2094 | 2095 | 2096 | 2097 | 2098 | 2099 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1970 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | 2055 | 2056 | 2057 | 2058 | 2059 | 2060 | 2061 | 2062 | 2063 | 2064 | 2065 | 2066 | 2067 | 2068 | 2069 | 2070 | 2071 | 2072 | 2073 | 2074 | 2075 | 2076 | 2077 | 2078 | 2079 | 2080 | 2081 | 2082 | 2083 | 2084 | 2085 | 2086 | 2087 | 2088 | 2089 | 2090 | 2091 | 2092 | 2093 | 2094 | 2095 | 2096 | 2097 | 2098 | 2099 |

FROM COPY FURNISHED TO DDC

122

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

CYBER LOADER 11-42J

LOW MAP - CPS

PWA OF THE LOAD 111  
LMA-1 OF THE LOAD 13465

TRANSFER ADDRESS -- CPS 2157

PROGRAM AND BLOCK ASSIGNMENTS.

| BLOCK    | ADDRESS | LENGTH | FILE       | DATE     | PROCESSOR LEVEL | HARDWARE | COMMENT                   |
|----------|---------|--------|------------|----------|-----------------|----------|---------------------------|
| CPS      | 111     | 222    | LGO        | 07/11/77 | FTN             | 400 410  | OPT.                      |
| APOL.C./ | 2331    | 23     |            |          |                 |          | FOR INITIALIZATION OF PWA |
| AOB.IO./ | 2354    | 131    |            |          |                 |          | FOR INITIALIZATION OF PWA |
| COMTRYS  | 2505    | 0      |            |          |                 |          | INITIALIZATION OF PWA     |
| COMIO    | 2505    | 64     | SL-FORTRAN | 07/11/76 | COMPASS         | 3        | 3-1-1                     |
| FORMSK   | 2571    | 41     | SL-FORTRAN | 07/11/76 | COMPASS         | 3        | 3-1-1                     |
| FLTOUS   | 2632    | 310    | SL-FORTRAN | 07/11/76 | COMPASS         | 3        | 3-1-1                     |
| FORSYS   | 3142    | 601    | SL-FORTRAN | 07/11/76 | COMPASS         | 3        | 3-1-1                     |
| OUTCOM   | 3743    | 154    | SL-FORTRAN | 07/11/76 | COMPASS         | 3        | 3-1-1                     |
| SYSDIO   | 4117    | 1      | SL-FORTRAN | 07/11/76 | COMPASS         | 3        | 3-1-1                     |
| PMAP     | 4120    | 352    | SL-FORTRAN | 07/11/76 | COMPASS         | 3        | 3-1-1                     |
| FORITL   | 4472    | 16     | SL-FORTRAN | 07/11/76 | COMPASS         | 3        | 3-1-1                     |
| GETITL   | 4510    | 42     | SL-FORTRAN | 07/11/76 | COMPASS         | 3        | 3-1-1                     |
| KOMRE    | 4552    | 495    | SL-FORTRAN | 07/11/76 | COMPASS         | 3        | 3-1-1                     |
| OUTC     | 5230    | 172    | SL-FORTRAN | 07/11/76 | COMPASS         | 3        | 3-1-1                     |
| ACON.RM/ | 5422    | 6      |            |          |                 |          |                           |
| CIO.RM   | 5430    | 40     | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| MOVE.RM/ | 5474    | 10     |            |          |                 |          |                           |
| PCT.RM   | 5500    | 64     | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| JMS.RM/  | 5584    | 233    | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| MEMC.RM/ | 6017    | 11     |            |          |                 |          |                           |
| OPES.FO/ | 6030    | 4      |            |          |                 |          |                           |
| ACPN.FO/ | 6033    | 1      |            |          |                 |          |                           |
| CPEN.RM  | 6034    | 235    | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| PUT.FO/  | 6301    | 7      |            |          |                 |          |                           |
| MAP.SQ   | 6310    | 1362   | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| ACST.FO/ | 7672    | 260    | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| CLSF.RM  | 10161   | 23     | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| GET.BT/  | 10294   | 5      |            |          |                 |          |                           |
| PIPT.SQ  | 10211   | 114    | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| WEOT.SQ  | 10325   | 142    | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| SKFL.FO/ | 10467   | 7      |            |          |                 |          |                           |
| SKPL.SQ  | 10476   | 47     | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| ERR.RM   | 10545   | 404    | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| CHMP.SQ  | 11151   | 7      | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| CSUP.RM  | 11160   | 65     | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| OPEN.SQ  | 11245   | 262    | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| OPEX.SQ  | 11527   | 14     | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| PUT.BT/  | 11543   | 11     |            |          |                 |          |                           |
| RLD.RM   | 11554   | 42     | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| CLSP.SQ  | 11616   | 132    | SL-SYSIO   | 07/28/76 | COMPASS         | 3        | 3-1-2                     |
| CLCV.FO/ | 11750   | 7      |            |          |                 |          |                           |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

| LOAD MAP - CPS  |       | CYBER LOADER 1 1-42    |            | CYBER LOADER 1 1-42 |         |
|-----------------|-------|------------------------|------------|---------------------|---------|
| CLSW.SQ         | 11757 | 123                    | SL-SYSIO   | 05/28/76 COMPASS    | 3. 7312 |
| REFN.FD/        | 12102 | 7                      |            |                     |         |
| REM.SQ          | 12111 | 31                     | SL-SYSIO   | 05/28/76 COMPASS    | 3. 7312 |
| GET.FD/         | 12142 | 7                      |            |                     |         |
| GET.RT/         | 12151 | 11                     |            |                     |         |
| GET.SQ          | 12162 | 135                    | SL-SYSIO   | 05/28/76 COMPASS    | 3. 7312 |
| Z.SQ            | 13217 | 101                    | SL-SYSIO   | 05/28/76 COMPASS    | 3. 7312 |
| FSU.SQ          | 13320 | 196                    | SL-SYSIO   | 05/28/76 COMPASS    | 3. 7312 |
| SYS.PM          | 13426 | 37                     | SL-NUCLEUS | 05/29/76 COMPASS    | 3. 7312 |
| .407 CP SECONDS |       | 255 MB CM STORAGE USED |            | 8 1231 10V 5        |         |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PAGE 1

COUNTS VS CPS

|     | S     | U     | R     | M     | P     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| SSS | 0.00  | 2.25  | 5.00  | 7.75  | 10.00 | 12.25 | 15.00 | 17.75 |
| SSU | 4.00  | 4.25  | 4.50  | 4.75  | 5.00  | 5.25  | 5.50  | 5.75  |
| SSK | 8.00  | 6.25  | 6.50  | 6.75  | 7.00  | 7.25  | 7.50  | 7.75  |
| SSM | 12.00 | 10.25 | 10.50 | 10.75 | 11.00 | 11.25 | 11.50 | 11.75 |
| SSD | 16.00 | 14.25 | 14.50 | 14.75 | 15.00 | 15.25 | 15.50 | 15.75 |
| SSG | 20.00 | 18.25 | 18.50 | 18.75 | 19.00 | 19.25 | 19.50 | 19.75 |
| SSO | 24.00 | 22.25 | 22.50 | 22.75 | 23.00 | 23.25 | 23.50 | 23.75 |
| SUS | 28.00 | 26.25 | 26.50 | 26.75 | 27.00 | 27.25 | 27.50 | 27.75 |
| SUU | 32.00 | 30.25 | 30.50 | 30.75 | 31.00 | 31.25 | 31.50 | 31.75 |
| SUK | 36.00 | 34.25 | 34.50 | 34.75 | 35.00 | 35.25 | 35.50 | 35.75 |
| SUM | 40.00 | 38.25 | 38.50 | 38.75 | 39.00 | 39.25 | 39.50 | 39.75 |
| SUD | 44.00 | 42.25 | 42.50 | 42.75 | 43.00 | 43.25 | 43.50 | 43.75 |
| SUG | 48.00 | 46.25 | 46.50 | 46.75 | 47.00 | 47.25 | 47.50 | 47.75 |
| SUO | 52.00 | 50.25 | 50.50 | 50.75 | 51.00 | 51.25 | 51.50 | 51.75 |
| SMS | 56.00 | 54.25 | 54.50 | 54.75 | 55.00 | 55.25 | 55.50 | 55.75 |
| SMU | 60.00 | 58.25 | 58.50 | 58.75 | 59.00 | 59.25 | 59.50 | 59.75 |
| SUK | 64.00 | 62.25 | 62.50 | 62.75 | 63.00 | 63.25 | 63.50 | 63.75 |
| SUM | 68.00 | 66.25 | 66.50 | 66.75 | 67.00 | 67.25 | 67.50 | 67.75 |
| SUD | 72.00 | 70.25 | 70.50 | 70.75 | 71.00 | 71.25 | 71.50 | 71.75 |
| SUG | 76.00 | 74.25 | 74.50 | 74.75 | 75.00 | 75.25 | 75.50 | 75.75 |
| SUO | 80.00 | 78.25 | 78.50 | 78.75 | 79.00 | 79.25 | 79.50 | 79.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

COUNTS VS CPS

|     | S      | U      | P      | M      | D      | K      | G      | O      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| SOS | 64.00  | 64.25  | 64.50  | 64.75  | 65.00  | 65.25  | 65.50  | 65.75  |
| SOU | 66.00  | 66.25  | 66.50  | 66.75  | 67.00  | 67.25  | 67.50  | 67.75  |
| SOR | 68.00  | 68.25  | 68.50  | 68.75  | 69.00  | 69.25  | 69.50  | 69.75  |
| SOW | 70.00  | 70.25  | 70.50  | 70.75  | 71.00  | 71.25  | 71.50  | 71.75  |
| SOD | 72.00  | 72.25  | 72.50  | 72.75  | 73.00  | 73.25  | 73.50  | 73.75  |
| SKS | 74.00  | 74.25  | 74.50  | 74.75  | 75.00  | 75.25  | 75.50  | 75.75  |
| SKU | 76.00  | 76.25  | 76.50  | 76.75  | 77.00  | 77.25  | 77.50  | 77.75  |
| SOR | 78.00  | 78.25  | 78.50  | 78.75  | 79.00  | 79.25  | 79.50  | 79.75  |
| SOS | 80.00  | 80.25  | 80.50  | 80.75  | 81.00  | 81.25  | 81.50  | 81.75  |
| SOU | 82.00  | 82.25  | 82.50  | 82.75  | 83.00  | 83.25  | 83.50  | 83.75  |
| SOR | 84.00  | 84.25  | 84.50  | 84.75  | 85.00  | 85.25  | 85.50  | 85.75  |
| SOW | 86.00  | 86.25  | 86.50  | 86.75  | 87.00  | 87.25  | 87.50  | 87.75  |
| SOD | 88.00  | 88.25  | 88.50  | 88.75  | 89.00  | 89.25  | 89.50  | 89.75  |
| SKS | 90.00  | 90.25  | 90.50  | 90.75  | 91.00  | 91.25  | 91.50  | 91.75  |
| SKU | 92.00  | 92.25  | 92.50  | 92.75  | 93.00  | 93.25  | 93.50  | 93.75  |
| SOR | 94.00  | 94.25  | 94.50  | 94.75  | 95.00  | 95.25  | 95.50  | 95.75  |
| SOS | 96.00  | 96.25  | 96.50  | 96.75  | 97.00  | 97.25  | 97.50  | 97.75  |
| SOU | 98.00  | 98.25  | 98.50  | 98.75  | 99.00  | 99.25  | 99.50  | 99.75  |
| SOR | 100.00 | 100.25 | 100.50 | 100.75 | 101.00 | 101.25 | 101.50 | 101.75 |
| SOW | 102.00 | 102.25 | 102.50 | 102.75 | 103.00 | 103.25 | 103.50 | 103.75 |
| SOD | 104.00 | 104.25 | 104.50 | 104.75 | 105.00 | 105.25 | 105.50 | 105.75 |
| SKS | 106.00 | 106.25 | 106.50 | 106.75 | 107.00 | 107.25 | 107.50 | 107.75 |
| SKU | 108.00 | 108.25 | 108.50 | 108.75 | 109.00 | 109.25 | 109.50 | 109.75 |
| SOR | 110.00 | 110.25 | 110.50 | 110.75 | 111.00 | 111.25 | 111.50 | 111.75 |
| SOS | 112.00 | 112.25 | 112.50 | 112.75 | 113.00 | 113.25 | 113.50 | 113.75 |
| SOU | 114.00 | 114.25 | 114.50 | 114.75 | 115.00 | 115.25 | 115.50 | 115.75 |
| SOR | 116.00 | 116.25 | 116.50 | 116.75 | 117.00 | 117.25 | 117.50 | 117.75 |
| SOW | 118.00 | 118.25 | 118.50 | 118.75 | 119.00 | 119.25 | 119.50 | 119.75 |
| SOD | 120.00 | 120.25 | 120.50 | 120.75 | 121.00 | 121.25 | 121.50 | 121.75 |
| SKS | 122.00 | 122.25 | 122.50 | 122.75 | 123.00 | 123.25 | 123.50 | 123.75 |
| SKU | 124.00 | 124.25 | 124.50 | 124.75 | 125.00 | 125.25 | 125.50 | 125.75 |
| SOR | 126.00 | 126.25 | 126.50 | 126.75 | 127.00 | 127.25 | 127.50 | 127.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PAGE 2

COUNTS VS CPS

|     | S      | U      | P      | M      | D      | K      | G      | C      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| USS | 129.00 | 128.25 | 128.50 | 128.75 | 129.00 | 129.25 | 129.50 | 129.75 |
| USU | 130.00 | 130.25 | 130.50 | 130.75 | 131.00 | 131.25 | 131.50 | 131.75 |
| USR | 132.00 | 132.25 | 132.50 | 132.75 | 133.00 | 133.25 | 133.50 | 133.75 |
| USW | 134.00 | 134.25 | 134.50 | 134.75 | 135.00 | 135.25 | 135.50 | 135.75 |
| USD | 136.00 | 136.25 | 136.50 | 136.75 | 137.00 | 137.25 | 137.50 | 137.75 |
| USK | 138.00 | 138.25 | 138.50 | 138.75 | 139.00 | 139.25 | 139.50 | 139.75 |
| USG | 140.00 | 140.25 | 140.50 | 140.75 | 141.00 | 141.25 | 141.50 | 141.75 |
| USO | 142.00 | 142.25 | 142.50 | 142.75 | 143.00 | 143.25 | 143.50 | 143.75 |
| UUS | 144.00 | 144.25 | 144.50 | 144.75 | 145.00 | 145.25 | 145.50 | 145.75 |
| UUS | 146.00 | 146.25 | 146.50 | 146.75 | 147.00 | 147.25 | 147.50 | 147.75 |
| UUR | 148.00 | 148.25 | 148.50 | 148.75 | 149.00 | 149.25 | 149.50 | 149.75 |
| UUN | 150.00 | 150.25 | 150.50 | 150.75 | 151.00 | 151.25 | 151.50 | 151.75 |
| UUD | 152.00 | 152.25 | 152.50 | 152.75 | 153.00 | 153.25 | 153.50 | 153.75 |
| UUK | 154.00 | 154.25 | 154.50 | 154.75 | 155.00 | 155.25 | 155.50 | 155.75 |
| UUG | 156.00 | 156.25 | 156.50 | 156.75 | 157.00 | 157.25 | 157.50 | 157.75 |
| UUS | 158.00 | 158.25 | 158.50 | 158.75 | 159.00 | 159.25 | 159.50 | 159.75 |
| URS | 160.00 | 160.25 | 160.50 | 160.75 | 161.00 | 161.25 | 161.50 | 161.75 |
| URU | 162.00 | 162.25 | 162.50 | 162.75 | 163.00 | 163.25 | 163.50 | 163.75 |
| URR | 164.00 | 164.25 | 164.50 | 164.75 | 165.00 | 165.25 | 165.50 | 165.75 |
| URW | 166.00 | 166.25 | 166.50 | 166.75 | 167.00 | 167.25 | 167.50 | 167.75 |
| URD | 168.00 | 168.25 | 168.50 | 168.75 | 169.00 | 169.25 | 169.50 | 169.75 |
| URK | 170.00 | 170.25 | 170.50 | 170.75 | 171.00 | 171.25 | 171.50 | 171.75 |
| URG | 172.00 | 172.25 | 172.50 | 172.75 | 173.00 | 173.25 | 173.50 | 173.75 |
| URO | 174.00 | 174.25 | 174.50 | 174.75 | 175.00 | 175.25 | 175.50 | 175.75 |
| UMS | 176.00 | 176.25 | 176.50 | 176.75 | 177.00 | 177.25 | 177.50 | 177.75 |
| UMU | 178.00 | 178.25 | 178.50 | 178.75 | 179.00 | 179.25 | 179.50 | 179.75 |
| UMR | 180.00 | 180.25 | 180.50 | 180.75 | 181.00 | 181.25 | 181.50 | 181.75 |
| UMW | 182.00 | 182.25 | 182.50 | 182.75 | 183.00 | 183.25 | 183.50 | 183.75 |
| UMD | 184.00 | 184.25 | 184.50 | 184.75 | 185.00 | 185.25 | 185.50 | 185.75 |
| UMK | 186.00 | 186.25 | 186.50 | 186.75 | 187.00 | 187.25 | 187.50 | 187.75 |
| UMG | 188.00 | 188.25 | 188.50 | 188.75 | 189.00 | 189.25 | 189.50 | 189.75 |
| UMU | 190.00 | 190.25 | 190.50 | 190.75 | 191.00 | 191.25 | 191.50 | 191.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

COUNTS VS CPS

PAGE 4

|     | S      | U      | P      | M      | D      | K      | G      | O      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| UDS | 192.00 | 192.25 | 192.50 | 192.75 | 193.00 | 193.25 | 193.50 | 193.75 |
| UDU | 194.00 | 194.25 | 194.50 | 194.75 | 195.00 | 195.25 | 195.50 | 195.75 |
| UDV | 196.00 | 196.25 | 196.50 | 196.75 | 197.00 | 197.25 | 197.50 | 197.75 |
| UDW | 198.00 | 198.25 | 198.50 | 198.75 | 199.00 | 199.25 | 199.50 | 199.75 |
| UDX | 200.00 | 200.25 | 200.50 | 200.75 | 201.00 | 201.25 | 201.50 | 201.75 |
| UDY | 202.00 | 202.25 | 202.50 | 202.75 | 203.00 | 203.25 | 203.50 | 203.75 |
| UDZ | 204.00 | 204.25 | 204.50 | 204.75 | 205.00 | 205.25 | 205.50 | 205.75 |
| UEG | 206.00 | 206.25 | 206.50 | 206.75 | 207.00 | 207.25 | 207.50 | 207.75 |
| UEH | 208.00 | 208.25 | 208.50 | 208.75 | 209.00 | 209.25 | 209.50 | 209.75 |
| UEI | 210.00 | 210.25 | 210.50 | 210.75 | 211.00 | 211.25 | 211.50 | 211.75 |
| UEJ | 212.00 | 212.25 | 212.50 | 212.75 | 213.00 | 213.25 | 213.50 | 213.75 |
| UEK | 214.00 | 214.25 | 214.50 | 214.75 | 215.00 | 215.25 | 215.50 | 215.75 |
| UEL | 216.00 | 216.25 | 216.50 | 216.75 | 217.00 | 217.25 | 217.50 | 217.75 |
| UEM | 218.00 | 218.25 | 218.50 | 218.75 | 219.00 | 219.25 | 219.50 | 219.75 |
| UEN | 220.00 | 220.25 | 220.50 | 220.75 | 221.00 | 221.25 | 221.50 | 221.75 |
| UEO | 222.00 | 222.25 | 222.50 | 222.75 | 223.00 | 223.25 | 223.50 | 223.75 |
| UEP | 224.00 | 224.25 | 224.50 | 224.75 | 225.00 | 225.25 | 225.50 | 225.75 |
| UEQ | 226.00 | 226.25 | 226.50 | 226.75 | 227.00 | 227.25 | 227.50 | 227.75 |
| UER | 228.00 | 228.25 | 228.50 | 228.75 | 229.00 | 229.25 | 229.50 | 229.75 |
| UES | 230.00 | 230.25 | 230.50 | 230.75 | 231.00 | 231.25 | 231.50 | 231.75 |
| UEU | 232.00 | 232.25 | 232.50 | 232.75 | 233.00 | 233.25 | 233.50 | 233.75 |
| UEV | 234.00 | 234.25 | 234.50 | 234.75 | 235.00 | 235.25 | 235.50 | 235.75 |
| UEW | 236.00 | 236.25 | 236.50 | 236.75 | 237.00 | 237.25 | 237.50 | 237.75 |
| UEX | 238.00 | 238.25 | 238.50 | 238.75 | 239.00 | 239.25 | 239.50 | 239.75 |
| UEY | 240.00 | 240.25 | 240.50 | 240.75 | 241.00 | 241.25 | 241.50 | 241.75 |
| UEZ | 242.00 | 242.25 | 242.50 | 242.75 | 243.00 | 243.25 | 243.50 | 243.75 |
| UEA | 244.00 | 244.25 | 244.50 | 244.75 | 245.00 | 245.25 | 245.50 | 245.75 |
| UEB | 246.00 | 246.25 | 246.50 | 246.75 | 247.00 | 247.25 | 247.50 | 247.75 |
| UEC | 248.00 | 248.25 | 248.50 | 248.75 | 249.00 | 249.25 | 249.50 | 249.75 |
| UED | 250.00 | 250.25 | 250.50 | 250.75 | 251.00 | 251.25 | 251.50 | 251.75 |
| UEE | 252.00 | 252.25 | 252.50 | 252.75 | 253.00 | 253.25 | 253.50 | 253.75 |
| UEF | 254.00 | 254.25 | 254.50 | 254.75 | 255.00 | 255.25 | 255.50 | 255.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PAGE 5

COUNTS VS CPS

5d7

|     | S      | U      | P      | M      | D      | K      | G      | C      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| RSS | 256.00 | 256.25 | 256.50 | 256.75 | 270.00 | 257.25 | 257.50 | 257.75 |
| RSU | 258.00 | 258.25 | 258.50 | 258.75 | 259.00 | 259.25 | 259.50 | 259.75 |
| RSV | 260.00 | 260.25 | 260.50 | 260.75 | 261.00 | 261.25 | 261.50 | 261.75 |
| RSM | 262.00 | 262.25 | 262.50 | 262.75 | 263.00 | 263.25 | 263.50 | 263.75 |
| RSP | 264.00 | 264.25 | 264.50 | 264.75 | 265.00 | 265.25 | 265.50 | 265.75 |
| RSK | 266.00 | 266.25 | 266.50 | 266.75 | 267.00 | 267.25 | 267.50 | 267.75 |
| RSG | 268.00 | 268.25 | 268.50 | 268.75 | 269.00 | 269.25 | 269.50 | 269.75 |
| RSD | 270.00 | 270.25 | 270.50 | 270.75 | 271.00 | 271.25 | 271.50 | 271.75 |
| RUS | 272.00 | 272.25 | 272.50 | 272.75 | 273.00 | 273.25 | 273.50 | 273.75 |
| RSU | 274.00 | 274.25 | 274.50 | 274.75 | 275.00 | 275.25 | 275.50 | 275.75 |
| RUR | 276.00 | 276.25 | 276.50 | 276.75 | 277.00 | 277.25 | 277.50 | 277.75 |
| RUM | 278.00 | 278.25 | 278.50 | 278.75 | 279.00 | 279.25 | 279.50 | 279.75 |
| RUD | 280.00 | 280.25 | 280.50 | 280.75 | 281.00 | 281.25 | 281.50 | 281.75 |
| RUX | 282.00 | 282.25 | 282.50 | 282.75 | 283.00 | 283.25 | 283.50 | 283.75 |
| RUG | 284.00 | 284.25 | 284.50 | 284.75 | 285.00 | 285.25 | 285.50 | 285.75 |
| RUD | 286.00 | 286.25 | 286.50 | 286.75 | 287.00 | 287.25 | 287.50 | 287.75 |
| RWS | 288.00 | 288.25 | 288.50 | 288.75 | 289.00 | 289.25 | 289.50 | 289.75 |
| RRU | 290.00 | 290.25 | 290.50 | 290.75 | 291.00 | 291.25 | 291.50 | 291.75 |
| RPR | 292.00 | 292.25 | 292.50 | 292.75 | 293.00 | 293.25 | 293.50 | 293.75 |
| RPM | 294.00 | 294.25 | 294.50 | 294.75 | 295.00 | 295.25 | 295.50 | 295.75 |
| RPO | 296.00 | 296.25 | 296.50 | 296.75 | 297.00 | 297.25 | 297.50 | 297.75 |
| RPK | 298.00 | 298.25 | 298.50 | 298.75 | 299.00 | 299.25 | 299.50 | 299.75 |
| RPG | 300.00 | 300.25 | 300.50 | 300.75 | 301.00 | 301.25 | 301.50 | 301.75 |
| RRO | 302.00 | 302.25 | 302.50 | 302.75 | 303.00 | 303.25 | 303.50 | 303.75 |
| RMS | 304.00 | 304.25 | 304.50 | 304.75 | 305.00 | 305.25 | 305.50 | 305.75 |
| RNU | 306.00 | 306.25 | 306.50 | 306.75 | 307.00 | 307.25 | 307.50 | 307.75 |
| RNR | 308.00 | 308.25 | 308.50 | 308.75 | 309.00 | 309.25 | 309.50 | 309.75 |
| RNW | 310.00 | 310.25 | 310.50 | 310.75 | 311.00 | 311.25 | 311.50 | 311.75 |
| RNX | 312.00 | 312.25 | 312.50 | 312.75 | 313.00 | 313.25 | 313.50 | 313.75 |
| RNY | 314.00 | 314.25 | 314.50 | 314.75 | 315.00 | 315.25 | 315.50 | 315.75 |
| RNG | 316.00 | 316.25 | 316.50 | 316.75 | 317.00 | 317.25 | 317.50 | 317.75 |
| RNO | 318.00 | 318.25 | 318.50 | 318.75 | 319.00 | 319.25 | 319.50 | 319.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PAGE 6

COUNTS VS CPS

|     | S      | U      | R      | M      | D      | K      | G      | D      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| R0S | 320.00 | 320.25 | 320.50 | 320.75 | 321.00 | 321.25 | 321.50 | 321.75 |
| R0U | 322.00 | 322.25 | 322.50 | 322.75 | 323.00 | 323.25 | 323.50 | 323.75 |
| R0R | 324.00 | 324.25 | 324.50 | 324.75 | 325.00 | 325.25 | 325.50 | 325.75 |
| R0W | 326.00 | 326.25 | 326.50 | 326.75 | 327.00 | 327.25 | 327.50 | 327.75 |
| R0D | 328.00 | 328.25 | 328.50 | 328.75 | 329.00 | 329.25 | 329.50 | 329.75 |
| R0G | 330.00 | 330.25 | 330.50 | 330.75 | 331.00 | 331.25 | 331.50 | 331.75 |
| R0K | 332.00 | 332.25 | 332.50 | 332.75 | 333.00 | 333.25 | 333.50 | 333.75 |
| R0D | 334.00 | 334.25 | 334.50 | 334.75 | 335.00 | 335.25 | 335.50 | 335.75 |
| R0S | 336.00 | 336.25 | 336.50 | 336.75 | 337.00 | 337.25 | 337.50 | 337.75 |
| R0U | 338.00 | 338.25 | 338.50 | 338.75 | 339.00 | 339.25 | 339.50 | 339.75 |
| R0R | 340.00 | 340.25 | 340.50 | 340.75 | 341.00 | 341.25 | 341.50 | 341.75 |
| R0W | 342.00 | 342.25 | 342.50 | 342.75 | 343.00 | 343.25 | 343.50 | 343.75 |
| R0D | 344.00 | 344.25 | 344.50 | 344.75 | 345.00 | 345.25 | 345.50 | 345.75 |
| R0G | 346.00 | 346.25 | 346.50 | 346.75 | 347.00 | 347.25 | 347.50 | 347.75 |
| R0K | 348.00 | 348.25 | 348.50 | 348.75 | 349.00 | 349.25 | 349.50 | 349.75 |
| R0D | 350.00 | 350.25 | 350.50 | 350.75 | 351.00 | 351.25 | 351.50 | 351.75 |
| R0S | 352.00 | 352.25 | 352.50 | 352.75 | 353.00 | 353.25 | 353.50 | 353.75 |
| R0U | 354.00 | 354.25 | 354.50 | 354.75 | 355.00 | 355.25 | 355.50 | 355.75 |
| R0R | 356.00 | 356.25 | 356.50 | 356.75 | 357.00 | 357.25 | 357.50 | 357.75 |
| R0W | 358.00 | 358.25 | 358.50 | 358.75 | 359.00 | 359.25 | 359.50 | 359.75 |
| R0D | 360.00 | 360.25 | 360.50 | 360.75 | 361.00 | 361.25 | 361.50 | 361.75 |
| R0G | 362.00 | 362.25 | 362.50 | 362.75 | 363.00 | 363.25 | 363.50 | 363.75 |
| R0K | 364.00 | 364.25 | 364.50 | 364.75 | 365.00 | 365.25 | 365.50 | 365.75 |
| R0D | 366.00 | 366.25 | 366.50 | 366.75 | 367.00 | 367.25 | 367.50 | 367.75 |
| R0S | 368.00 | 368.25 | 368.50 | 368.75 | 369.00 | 369.25 | 369.50 | 369.75 |
| R0U | 370.00 | 370.25 | 370.50 | 370.75 | 371.00 | 371.25 | 371.50 | 371.75 |
| R0R | 372.00 | 372.25 | 372.50 | 372.75 | 373.00 | 373.25 | 373.50 | 373.75 |
| R0W | 374.00 | 374.25 | 374.50 | 374.75 | 375.00 | 375.25 | 375.50 | 375.75 |
| R0D | 376.00 | 376.25 | 376.50 | 376.75 | 377.00 | 377.25 | 377.50 | 377.75 |
| R0G | 378.00 | 378.25 | 378.50 | 378.75 | 379.00 | 379.25 | 379.50 | 379.75 |
| R0K | 380.00 | 380.25 | 380.50 | 380.75 | 381.00 | 381.25 | 381.50 | 381.75 |
| R0D | 382.00 | 382.25 | 382.50 | 382.75 | 383.00 | 383.25 | 383.50 | 383.75 |

PAGE - 7

## CPS

131

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PAG 8

COUNTS VS CPS

|     | S      | U      | P      | M      | D      | K      | G      | O      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| MDS | 448.00 | 448.25 | 448.50 | 448.75 | 449.00 | 449.25 | 449.50 | 449.75 |
| MDU | 450.00 | 450.25 | 450.50 | 450.75 | 451.00 | 451.25 | 451.50 | 451.75 |
| MDR | 452.00 | 452.25 | 452.50 | 452.75 | 453.00 | 453.25 | 453.50 | 453.75 |
| MDW | 454.00 | 454.25 | 454.50 | 454.75 | 455.00 | 455.25 | 455.50 | 455.75 |
| MDO | 456.00 | 456.25 | 456.50 | 456.75 | 457.00 | 457.25 | 457.50 | 457.75 |
| MOK | 458.00 | 458.25 | 458.50 | 458.75 | 459.00 | 459.25 | 459.50 | 459.75 |
| MOK | 460.00 | 460.25 | 460.50 | 460.75 | 461.00 | 461.25 | 461.50 | 461.75 |
| MGO | 462.00 | 462.25 | 462.50 | 462.75 | 463.00 | 463.25 | 463.50 | 463.75 |
| MKS | 464.00 | 464.25 | 464.50 | 464.75 | 465.00 | 465.25 | 465.50 | 465.75 |
| MKU | 466.00 | 466.25 | 466.50 | 466.75 | 467.00 | 467.25 | 467.50 | 467.75 |
| MKR | 468.00 | 468.25 | 468.50 | 468.75 | 469.00 | 469.25 | 469.50 | 469.75 |
| MKW | 470.00 | 470.25 | 470.50 | 470.75 | 471.00 | 471.25 | 471.50 | 471.75 |
| MKO | 472.00 | 472.25 | 472.50 | 472.75 | 473.00 | 473.25 | 473.50 | 473.75 |
| MKG | 474.00 | 474.25 | 474.50 | 474.75 | 475.00 | 475.25 | 475.50 | 475.75 |
| MKG | 476.00 | 476.25 | 476.50 | 476.75 | 477.00 | 477.25 | 477.50 | 477.75 |
| MKO | 478.00 | 478.25 | 478.50 | 478.75 | 479.00 | 479.25 | 479.50 | 479.75 |
| MGS | 480.00 | 480.25 | 480.50 | 480.75 | 481.00 | 481.25 | 481.50 | 481.75 |
| MGU | 482.00 | 482.25 | 482.50 | 482.75 | 483.00 | 483.25 | 483.50 | 483.75 |
| MGR | 484.00 | 484.25 | 484.50 | 484.75 | 485.00 | 485.25 | 485.50 | 485.75 |
| MGR | 486.00 | 486.25 | 486.50 | 486.75 | 487.00 | 487.25 | 487.50 | 487.75 |
| MGO | 488.00 | 488.25 | 488.50 | 488.75 | 489.00 | 489.25 | 489.50 | 489.75 |
| MGR | 490.00 | 490.25 | 490.50 | 490.75 | 491.00 | 491.25 | 491.50 | 491.75 |
| MGG | 492.00 | 492.25 | 492.50 | 492.75 | 493.00 | 493.25 | 493.50 | 493.75 |
| MGO | 494.00 | 494.25 | 494.50 | 494.75 | 495.00 | 495.25 | 495.50 | 495.75 |
| MOS | 496.00 | 496.25 | 496.50 | 496.75 | 497.00 | 497.25 | 497.50 | 497.75 |
| MOU | 498.00 | 498.25 | 498.50 | 498.75 | 499.00 | 499.25 | 499.50 | 499.75 |
| MOR | 500.00 | 500.25 | 500.50 | 500.75 | 501.00 | 501.25 | 501.50 | 501.75 |
| MOW | 502.00 | 502.25 | 502.50 | 502.75 | 503.00 | 503.25 | 503.50 | 503.75 |
| MOW | 504.00 | 504.25 | 504.50 | 504.75 | 505.00 | 505.25 | 505.50 | 505.75 |
| MOK | 506.00 | 506.25 | 506.50 | 506.75 | 507.00 | 507.25 | 507.50 | 507.75 |
| MOK | 508.00 | 508.25 | 508.50 | 508.75 | 509.00 | 509.25 | 509.50 | 509.75 |
| MOD | 510.00 | 510.25 | 510.50 | 510.75 | 511.00 | 511.25 | 511.50 | 511.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PAGE 9

COUNTS VS CPS

|     | S      | U      | R      | M      | D      | K      | G      | O      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| DSS | 512.00 | 512.25 | 512.50 | 512.75 | 513.00 | 513.25 | 513.50 | 513.75 |
| DSU | 514.00 | 514.25 | 514.50 | 514.75 | 515.00 | 515.25 | 515.50 | 515.75 |
| DSR | 516.00 | 516.25 | 516.50 | 516.75 | 517.00 | 517.25 | 517.50 | 517.75 |
| DSM | 518.00 | 518.25 | 518.50 | 518.75 | 519.00 | 519.25 | 519.50 | 519.75 |
| DSO | 520.00 | 520.25 | 520.50 | 520.75 | 521.00 | 521.25 | 521.50 | 521.75 |
| DSK | 522.00 | 522.25 | 522.50 | 522.75 | 523.00 | 523.25 | 523.50 | 523.75 |
| DSG | 524.00 | 524.25 | 524.50 | 524.75 | 525.00 | 525.25 | 525.50 | 525.75 |
| DSO | 526.00 | 526.25 | 526.50 | 526.75 | 527.00 | 527.25 | 527.50 | 527.75 |
| DUS | 528.00 | 528.25 | 528.50 | 528.75 | 529.00 | 529.25 | 529.50 | 529.75 |
| DUU | 530.00 | 530.25 | 530.50 | 530.75 | 531.00 | 531.25 | 531.50 | 531.75 |
| DUR | 532.00 | 532.25 | 532.50 | 532.75 | 533.00 | 533.25 | 533.50 | 533.75 |
| DUM | 534.00 | 534.25 | 534.50 | 534.75 | 535.00 | 535.25 | 535.50 | 535.75 |
| DUD | 536.00 | 536.25 | 536.50 | 536.75 | 537.00 | 537.25 | 537.50 | 537.75 |
| DUK | 538.00 | 538.25 | 538.50 | 538.75 | 539.00 | 539.25 | 539.50 | 539.75 |
| DUG | 540.00 | 540.25 | 540.50 | 540.75 | 541.00 | 541.25 | 541.50 | 541.75 |
| DUO | 542.00 | 542.25 | 542.50 | 542.75 | 543.00 | 543.25 | 543.50 | 543.75 |
| DPS | 544.00 | 544.25 | 544.50 | 544.75 | 545.00 | 545.25 | 545.50 | 545.75 |
| DPU | 546.00 | 546.25 | 546.50 | 546.75 | 547.00 | 547.25 | 547.50 | 547.75 |
| DPR | 548.00 | 548.25 | 548.50 | 548.75 | 549.00 | 549.25 | 549.50 | 549.75 |
| DPK | 550.00 | 550.25 | 550.50 | 550.75 | 551.00 | 551.25 | 551.50 | 551.75 |
| DPG | 552.00 | 552.25 | 552.50 | 552.75 | 553.00 | 553.25 | 553.50 | 553.75 |
| DPK | 554.00 | 554.25 | 554.50 | 554.75 | 555.00 | 555.25 | 555.50 | 555.75 |
| DPG | 556.00 | 556.25 | 556.50 | 556.75 | 557.00 | 557.25 | 557.50 | 557.75 |
| DRO | 558.00 | 558.25 | 558.50 | 558.75 | 559.00 | 559.25 | 559.50 | 559.75 |
| DMS | 560.00 | 560.25 | 560.50 | 560.75 | 561.00 | 561.25 | 561.50 | 561.75 |
| DMU | 562.00 | 562.25 | 562.50 | 562.75 | 563.00 | 563.25 | 563.50 | 563.75 |
| DMR | 564.00 | 564.25 | 564.50 | 564.75 | 565.00 | 565.25 | 565.50 | 565.75 |
| DMW | 566.00 | 566.25 | 566.50 | 566.75 | 567.00 | 567.25 | 567.50 | 567.75 |
| DMD | 568.00 | 568.25 | 568.50 | 568.75 | 569.00 | 569.25 | 569.50 | 569.75 |
| DMK | 570.00 | 570.25 | 570.50 | 570.75 | 571.00 | 571.25 | 571.50 | 571.75 |
| DME | 572.00 | 572.25 | 572.50 | 572.75 | 573.00 | 573.25 | 573.50 | 573.75 |
| DMO | 574.00 | 574.25 | 574.50 | 574.75 | 575.00 | 575.25 | 575.50 | 575.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PAGE 10

COUNTS VS CPS

|     | S      | U      | P      | M      | F      | K      | G      | D      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
|     | CPS    |        |        |        |        |        |        |        |
| DDG | 575.00 | 576.25 | 576.50 | 576.75 | 577.00 | 577.25 | 577.50 | 577.75 |
| DDU | 578.00 | 578.25 | 578.50 | 578.75 | 579.00 | 579.25 | 579.50 | 579.75 |
| DDV | 580.00 | 580.25 | 580.50 | 580.75 | 581.00 | 581.25 | 581.50 | 581.75 |
| DDW | 582.00 | 582.25 | 582.50 | 582.75 | 583.00 | 583.25 | 583.50 | 583.75 |
| DDX | 584.00 | 584.25 | 584.50 | 584.75 | 585.00 | 585.25 | 585.50 | 585.75 |
| DDY | 586.00 | 586.25 | 586.50 | 586.75 | 587.00 | 587.25 | 587.50 | 587.75 |
| DDZ | 588.00 | 588.25 | 588.50 | 588.75 | 589.00 | 589.25 | 589.50 | 589.75 |
| DDA | 590.00 | 590.25 | 590.50 | 590.75 | 591.00 | 591.25 | 591.50 | 591.75 |
| DDK | 592.00 | 592.25 | 592.50 | 592.75 | 593.00 | 593.25 | 593.50 | 593.75 |
| DDL | 594.00 | 594.25 | 594.50 | 594.75 | 595.00 | 595.25 | 595.50 | 595.75 |
| DDM | 596.00 | 596.25 | 596.50 | 596.75 | 597.00 | 597.25 | 597.50 | 597.75 |
| DDN | 598.00 | 598.25 | 598.50 | 598.75 | 599.00 | 599.25 | 599.50 | 599.75 |
| DDO | 600.00 | 600.25 | 600.50 | 600.75 | 601.00 | 601.25 | 601.50 | 601.75 |
| DDP | 602.00 | 602.25 | 602.50 | 602.75 | 603.00 | 603.25 | 603.50 | 603.75 |
| DDQ | 604.00 | 604.25 | 604.50 | 604.75 | 605.00 | 605.25 | 605.50 | 605.75 |
| DDR | 606.00 | 606.25 | 606.50 | 606.75 | 607.00 | 607.25 | 607.50 | 607.75 |
| DDS | 608.00 | 608.25 | 608.50 | 608.75 | 609.00 | 609.25 | 609.50 | 609.75 |
| DDT | 610.00 | 610.25 | 610.50 | 610.75 | 611.00 | 611.25 | 611.50 | 611.75 |
| DDU | 612.00 | 612.25 | 612.50 | 612.75 | 613.00 | 613.25 | 613.50 | 613.75 |
| DDV | 614.00 | 614.25 | 614.50 | 614.75 | 615.00 | 615.25 | 615.50 | 615.75 |
| DDW | 616.00 | 616.25 | 616.50 | 616.75 | 617.00 | 617.25 | 617.50 | 617.75 |
| DDX | 618.00 | 618.25 | 618.50 | 618.75 | 619.00 | 619.25 | 619.50 | 619.75 |
| DDY | 620.00 | 620.25 | 620.50 | 620.75 | 621.00 | 621.25 | 621.50 | 621.75 |
| DDZ | 622.00 | 622.25 | 622.50 | 622.75 | 623.00 | 623.25 | 623.50 | 623.75 |
| DDA | 624.00 | 624.25 | 624.50 | 624.75 | 625.00 | 625.25 | 625.50 | 625.75 |
| DDK | 626.00 | 626.25 | 626.50 | 626.75 | 627.00 | 627.25 | 627.50 | 627.75 |
| DDL | 628.00 | 628.25 | 628.50 | 628.75 | 629.00 | 629.25 | 629.50 | 629.75 |
| DDM | 630.00 | 630.25 | 630.50 | 630.75 | 631.00 | 631.25 | 631.50 | 631.75 |
| DDN | 632.00 | 632.25 | 632.50 | 632.75 | 633.00 | 633.25 | 633.50 | 633.75 |
| DDO | 634.00 | 634.25 | 634.50 | 634.75 | 635.00 | 635.25 | 635.50 | 635.75 |
| DDP | 636.00 | 636.25 | 636.50 | 636.75 | 637.00 | 637.25 | 637.50 | 637.75 |
| DDQ | 638.00 | 638.25 | 638.50 | 638.75 | 639.00 | 639.25 | 639.50 | 639.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PAGE 11

COUNTS VS CPS

|     | S      | U      | R      | M      | D      | K      | G      | O      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| KSS | 640.00 | 640.25 | 640.50 | 640.75 | 641.00 | 641.25 | 641.50 | 641.75 |
| KSU | 642.00 | 642.25 | 642.50 | 642.75 | 643.00 | 643.25 | 643.50 | 643.75 |
| KSR | 644.00 | 644.25 | 644.50 | 644.75 | 645.00 | 645.25 | 645.50 | 645.75 |
| KSM | 646.00 | 646.25 | 646.50 | 646.75 | 647.00 | 647.25 | 647.50 | 647.75 |
| KSD | 648.00 | 648.25 | 648.50 | 648.75 | 649.00 | 649.25 | 649.50 | 649.75 |
| KSK | 650.00 | 650.25 | 650.50 | 650.75 | 651.00 | 651.25 | 651.50 | 651.75 |
| KSG | 652.00 | 652.25 | 652.50 | 652.75 | 653.00 | 653.25 | 653.50 | 653.75 |
| KSO | 654.00 | 654.25 | 654.50 | 654.75 | 655.00 | 655.25 | 655.50 | 655.75 |
| KUS | 656.00 | 656.25 | 656.50 | 656.75 | 657.00 | 657.25 | 657.50 | 657.75 |
| KUU | 658.00 | 658.25 | 658.50 | 658.75 | 659.00 | 659.25 | 659.50 | 659.75 |
| KUR | 660.00 | 660.25 | 660.50 | 660.75 | 661.00 | 661.25 | 661.50 | 661.75 |
| KUR | 662.00 | 662.25 | 662.50 | 662.75 | 663.00 | 663.25 | 663.50 | 663.75 |
| KUD | 664.00 | 664.25 | 664.50 | 664.75 | 665.00 | 665.25 | 665.50 | 665.75 |
| KUK | 666.00 | 666.25 | 666.50 | 666.75 | 667.00 | 667.25 | 667.50 | 667.75 |
| KUG | 668.00 | 668.25 | 668.50 | 668.75 | 669.00 | 669.25 | 669.50 | 669.75 |
| KUD | 670.00 | 670.25 | 670.50 | 670.75 | 671.00 | 671.25 | 671.50 | 671.75 |
| KPS | 672.00 | 672.25 | 672.50 | 672.75 | 673.00 | 673.25 | 673.50 | 673.75 |
| KRU | 674.00 | 674.25 | 674.50 | 674.75 | 675.00 | 675.25 | 675.50 | 675.75 |
| KPR | 676.00 | 676.25 | 676.50 | 676.75 | 677.00 | 677.25 | 677.50 | 677.75 |
| KPM | 678.00 | 678.25 | 678.50 | 678.75 | 679.00 | 679.25 | 679.50 | 679.75 |
| KPN | 680.00 | 680.25 | 680.50 | 680.75 | 681.00 | 681.25 | 681.50 | 681.75 |
| KRK | 682.00 | 682.25 | 682.50 | 682.75 | 683.00 | 683.25 | 683.50 | 683.75 |
| KRG | 684.00 | 684.25 | 684.50 | 684.75 | 685.00 | 685.25 | 685.50 | 685.75 |
| KRO | 686.00 | 686.25 | 686.50 | 686.75 | 687.00 | 687.25 | 687.50 | 687.75 |
| KWS | 688.00 | 688.25 | 688.50 | 688.75 | 689.00 | 689.25 | 689.50 | 689.75 |
| KWU | 690.00 | 690.25 | 690.50 | 690.75 | 691.00 | 691.25 | 691.50 | 691.75 |
| KWR | 692.00 | 692.25 | 692.50 | 692.75 | 693.00 | 693.25 | 693.50 | 693.75 |
| KWN | 694.00 | 694.25 | 694.50 | 694.75 | 695.00 | 695.25 | 695.50 | 695.75 |
| KWD | 696.00 | 696.25 | 696.50 | 696.75 | 697.00 | 697.25 | 697.50 | 697.75 |
| KWK | 698.00 | 698.25 | 698.50 | 698.75 | 699.00 | 699.25 | 699.50 | 699.75 |
| KWO | 700.00 | 700.25 | 700.50 | 700.75 | 701.00 | 701.25 | 701.50 | 701.75 |
| KWO | 702.00 | 702.25 | 702.50 | 702.75 | 703.00 | 703.25 | 703.50 | 703.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PAGE 12

COUNTS VS CPS

|     | S      | U      | P      | M      | N      | K      | G      | D      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| KOS | 704.00 | 704.25 | 704.50 | 704.75 | 705.00 | 705.25 | 705.50 | 705.75 |
| KOU | 706.00 | 706.25 | 706.50 | 706.75 | 707.00 | 707.25 | 707.50 | 707.75 |
| KOV | 708.00 | 708.25 | 708.50 | 708.75 | 709.00 | 709.25 | 709.50 | 709.75 |
| KOW | 710.00 | 710.25 | 710.50 | 710.75 | 711.00 | 711.25 | 711.50 | 711.75 |
| KOX | 712.00 | 712.25 | 712.50 | 712.75 | 713.00 | 713.25 | 713.50 | 713.75 |
| KOK | 714.00 | 714.25 | 714.50 | 714.75 | 715.00 | 715.25 | 715.50 | 715.75 |
| KOG | 716.00 | 716.25 | 716.50 | 716.75 | 717.00 | 717.25 | 717.50 | 717.75 |
| KOO | 718.00 | 718.25 | 718.50 | 718.75 | 719.00 | 719.25 | 719.50 | 719.75 |
| KKS | 720.00 | 720.25 | 720.50 | 720.75 | 721.00 | 721.25 | 721.50 | 721.75 |
| KKU | 722.00 | 722.25 | 722.50 | 722.75 | 723.00 | 723.25 | 723.50 | 723.75 |
| KKV | 724.00 | 724.25 | 724.50 | 724.75 | 725.00 | 725.25 | 725.50 | 725.75 |
| KKW | 726.00 | 726.25 | 726.50 | 726.75 | 727.00 | 727.25 | 727.50 | 727.75 |
| KKO | 728.00 | 728.25 | 728.50 | 728.75 | 729.00 | 729.25 | 729.50 | 729.75 |
| KKK | 730.00 | 730.25 | 730.50 | 730.75 | 731.00 | 731.25 | 731.50 | 731.75 |
| KKG | 732.00 | 732.25 | 732.50 | 732.75 | 733.00 | 733.25 | 733.50 | 733.75 |
| KKO | 734.00 | 734.25 | 734.50 | 734.75 | 735.00 | 735.25 | 735.50 | 735.75 |
| KGS | 736.00 | 736.25 | 736.50 | 736.75 | 737.00 | 737.25 | 737.50 | 737.75 |
| KGU | 738.00 | 738.25 | 738.50 | 738.75 | 739.00 | 739.25 | 739.50 | 739.75 |
| KGV | 740.00 | 740.25 | 740.50 | 740.75 | 741.00 | 741.25 | 741.50 | 741.75 |
| KGW | 742.00 | 742.25 | 742.50 | 742.75 | 743.00 | 743.25 | 743.50 | 743.75 |
| KGX | 744.00 | 744.25 | 744.50 | 744.75 | 745.00 | 745.25 | 745.50 | 745.75 |
| KOK | 746.00 | 746.25 | 746.50 | 746.75 | 747.00 | 747.25 | 747.50 | 747.75 |
| KOG | 748.00 | 748.25 | 748.50 | 748.75 | 749.00 | 749.25 | 749.50 | 749.75 |
| KOO | 750.00 | 750.25 | 750.50 | 750.75 | 751.00 | 751.25 | 751.50 | 751.75 |
| KOS | 752.00 | 752.25 | 752.50 | 752.75 | 753.00 | 753.25 | 753.50 | 753.75 |
| KOU | 754.00 | 754.25 | 754.50 | 754.75 | 755.00 | 755.25 | 755.50 | 755.75 |
| KOV | 756.00 | 756.25 | 756.50 | 756.75 | 757.00 | 757.25 | 757.50 | 757.75 |
| KOW | 758.00 | 758.25 | 758.50 | 758.75 | 759.00 | 759.25 | 759.50 | 759.75 |
| KOX | 760.00 | 760.25 | 760.50 | 760.75 | 761.00 | 761.25 | 761.50 | 761.75 |
| KOK | 762.00 | 762.25 | 762.50 | 762.75 | 763.00 | 763.25 | 763.50 | 763.75 |
| KOG | 764.00 | 764.25 | 764.50 | 764.75 | 765.00 | 765.25 | 765.50 | 765.75 |
| KOO | 766.00 | 766.25 | 766.50 | 766.75 | 767.00 | 767.25 | 767.50 | 767.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PAGE 13

COUNTS VS CPS

|     | S      | U      | R      | M      | N      | K      | G      | O      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| GSS | 768.00 | 768.25 | 768.50 | 768.75 | 769.00 | 769.25 | 769.50 | 769.75 |
| GSU | 770.00 | 770.25 | 770.50 | 770.75 | 771.00 | 771.25 | 771.50 | 771.75 |
| GSR | 772.00 | 772.25 | 772.50 | 772.75 | 773.00 | 773.25 | 773.50 | 773.75 |
| GSM | 774.00 | 774.25 | 774.50 | 774.75 | 775.00 | 775.25 | 775.50 | 775.75 |
| GSD | 776.00 | 776.25 | 776.50 | 776.75 | 777.00 | 777.25 | 777.50 | 777.75 |
| GSF | 778.00 | 778.25 | 778.50 | 778.75 | 779.00 | 779.25 | 779.50 | 779.75 |
| GSG | 780.00 | 780.25 | 780.50 | 780.75 | 781.00 | 781.25 | 781.50 | 781.75 |
| GSO | 782.00 | 782.25 | 782.50 | 782.75 | 783.00 | 783.25 | 783.50 | 783.75 |
| GUS | 784.00 | 784.25 | 784.50 | 784.75 | 785.00 | 785.25 | 785.50 | 785.75 |
| GUU | 786.00 | 786.25 | 786.50 | 786.75 | 787.00 | 787.25 | 787.50 | 787.75 |
| GUR | 788.00 | 788.25 | 788.50 | 788.75 | 789.00 | 789.25 | 789.50 | 789.75 |
| GUM | 790.00 | 790.25 | 790.50 | 790.75 | 791.00 | 791.25 | 791.50 | 791.75 |
| GUD | 792.00 | 792.25 | 792.50 | 792.75 | 793.00 | 793.25 | 793.50 | 793.75 |
| GUG | 794.00 | 794.25 | 794.50 | 794.75 | 795.00 | 795.25 | 795.50 | 795.75 |
| GUG | 796.00 | 796.25 | 796.50 | 796.75 | 797.00 | 797.25 | 797.50 | 797.75 |
| GUO | 798.00 | 798.25 | 798.50 | 798.75 | 799.00 | 799.25 | 799.50 | 799.75 |
| GRS | 800.00 | 800.25 | 800.50 | 800.75 | 801.00 | 801.25 | 801.50 | 801.75 |
| GRU | 802.00 | 802.25 | 802.50 | 802.75 | 803.00 | 803.25 | 803.50 | 803.75 |
| GRM | 804.00 | 804.25 | 804.50 | 804.75 | 805.00 | 805.25 | 805.50 | 805.75 |
| GRD | 806.00 | 806.25 | 806.50 | 806.75 | 807.00 | 807.25 | 807.50 | 807.75 |
| GRK | 808.00 | 808.25 | 808.50 | 808.75 | 809.00 | 809.25 | 809.50 | 809.75 |
| GRG | 810.00 | 810.25 | 810.50 | 810.75 | 811.00 | 811.25 | 811.50 | 811.75 |
| GRU | 812.00 | 812.25 | 812.50 | 812.75 | 813.00 | 813.25 | 813.50 | 813.75 |
| GRU | 814.00 | 814.25 | 814.50 | 814.75 | 815.00 | 815.25 | 815.50 | 815.75 |
| GMS | 816.00 | 816.25 | 816.50 | 816.75 | 817.00 | 817.25 | 817.50 | 817.75 |
| GMD | 818.00 | 818.25 | 818.50 | 818.75 | 819.00 | 819.25 | 819.50 | 819.75 |
| GMP | 820.00 | 820.25 | 820.50 | 820.75 | 821.00 | 821.25 | 821.50 | 821.75 |
| GWN | 822.00 | 822.25 | 822.50 | 822.75 | 823.00 | 823.25 | 823.50 | 823.75 |
| GMD | 824.00 | 824.25 | 824.50 | 824.75 | 825.00 | 825.25 | 825.50 | 825.75 |
| GWK | 826.00 | 826.25 | 826.50 | 826.75 | 827.00 | 827.25 | 827.50 | 827.75 |
| GMG | 828.00 | 828.25 | 828.50 | 828.75 | 829.00 | 829.25 | 829.50 | 829.75 |
| GMO | 830.00 | 830.25 | 830.50 | 830.75 | 831.00 | 831.25 | 831.50 | 831.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

COURTS VS CPS

PAGE 14

|     | S      | U      | E      | M      | F      | X      | G      | D      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| GDS | 832.00 | 832.25 | 832.50 | 832.75 | 833.00 | 833.25 | 833.50 | 833.75 |
| GDU | 834.00 | 834.25 | 834.50 | 834.75 | 835.00 | 835.25 | 835.50 | 835.75 |
| GDR | 836.00 | 836.25 | 836.50 | 836.75 | 837.00 | 837.25 | 837.50 | 837.75 |
| GDM | 838.00 | 838.25 | 838.50 | 838.75 | 839.00 | 839.25 | 839.50 | 839.75 |
| GDN | 840.00 | 840.25 | 840.50 | 840.75 | 841.00 | 841.25 | 841.50 | 841.75 |
| GDK | 842.00 | 842.25 | 842.50 | 842.75 | 843.00 | 843.25 | 843.50 | 843.75 |
| GDG | 844.00 | 844.25 | 844.50 | 844.75 | 845.00 | 845.25 | 845.50 | 845.75 |
| GDD | 846.00 | 846.25 | 846.50 | 846.75 | 847.00 | 847.25 | 847.50 | 847.75 |
| GKS | 848.00 | 848.25 | 848.50 | 848.75 | 849.00 | 849.25 | 849.50 | 849.75 |
| GKU | 850.00 | 850.25 | 850.50 | 850.75 | 851.00 | 851.25 | 851.50 | 851.75 |
| GKR | 852.00 | 852.25 | 852.50 | 852.75 | 853.00 | 853.25 | 853.50 | 853.75 |
| GKW | 854.00 | 854.25 | 854.50 | 854.75 | 855.00 | 855.25 | 855.50 | 855.75 |
| GKO | 856.00 | 856.25 | 856.50 | 856.75 | 857.00 | 857.25 | 857.50 | 857.75 |
| GKK | 858.00 | 858.25 | 858.50 | 858.75 | 859.00 | 859.25 | 859.50 | 859.75 |
| GKG | 860.00 | 860.25 | 860.50 | 860.75 | 861.00 | 861.25 | 861.50 | 861.75 |
| GKO | 862.00 | 862.25 | 862.50 | 862.75 | 863.00 | 863.25 | 863.50 | 863.75 |
| GGG | 864.00 | 864.25 | 864.50 | 864.75 | 865.00 | 865.25 | 865.50 | 865.75 |
| GGU | 866.00 | 866.25 | 866.50 | 866.75 | 867.00 | 867.25 | 867.50 | 867.75 |
| GGK | 868.00 | 868.25 | 868.50 | 868.75 | 869.00 | 869.25 | 869.50 | 869.75 |
| GGM | 870.00 | 870.25 | 870.50 | 870.75 | 871.00 | 871.25 | 871.50 | 871.75 |
| GGD | 872.00 | 872.25 | 872.50 | 872.75 | 873.00 | 873.25 | 873.50 | 873.75 |
| GGK | 874.00 | 874.25 | 874.50 | 874.75 | 875.00 | 875.25 | 875.50 | 875.75 |
| GGG | 876.00 | 876.25 | 876.50 | 876.75 | 877.00 | 877.25 | 877.50 | 877.75 |
| GGD | 878.00 | 878.25 | 878.50 | 878.75 | 879.00 | 879.25 | 879.50 | 879.75 |
| GDS | 880.00 | 880.25 | 880.50 | 880.75 | 881.00 | 881.25 | 881.50 | 881.75 |
| GDU | 882.00 | 882.25 | 882.50 | 882.75 | 883.00 | 883.25 | 883.50 | 883.75 |
| GDR | 884.00 | 884.25 | 884.50 | 884.75 | 885.00 | 885.25 | 885.50 | 885.75 |
| GDM | 886.00 | 886.25 | 886.50 | 886.75 | 887.00 | 887.25 | 887.50 | 887.75 |
| GDN | 888.00 | 888.25 | 888.50 | 888.75 | 889.00 | 889.25 | 889.50 | 889.75 |
| GDK | 890.00 | 890.25 | 890.50 | 890.75 | 891.00 | 891.25 | 891.50 | 891.75 |
| GDG | 892.00 | 892.25 | 892.50 | 892.75 | 893.00 | 893.25 | 893.50 | 893.75 |
| GDD | 894.00 | 894.25 | 894.50 | 894.75 | 895.00 | 895.25 | 895.50 | 895.75 |

PAGE 1F

COURTS VS CPS

|     | S      | U      | V      | W      | F      | K      | G      | O      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| CSS | 896.00 | 896.25 | 896.50 | 896.75 | 897.00 | 897.25 | 897.50 | 897.75 |
| CSU | 898.00 | 898.25 | 898.50 | 898.75 | 899.00 | 899.25 | 899.50 | 899.75 |
| CSV | 900.00 | 900.25 | 900.50 | 900.75 | 901.00 | 901.25 | 901.50 | 901.75 |
| CSW | 902.00 | 902.25 | 902.50 | 902.75 | 903.00 | 903.25 | 903.50 | 903.75 |
| CSX | 904.00 | 904.25 | 904.50 | 904.75 | 905.00 | 905.25 | 905.50 | 905.75 |
| CSY | 906.00 | 906.25 | 906.50 | 906.75 | 907.00 | 907.25 | 907.50 | 907.75 |
| CSZ | 908.00 | 908.25 | 908.50 | 908.75 | 909.00 | 909.25 | 909.50 | 909.75 |
| CSA | 910.00 | 910.25 | 910.50 | 910.75 | 911.00 | 911.25 | 911.50 | 911.75 |
| CUB | 912.00 | 912.25 | 912.50 | 912.75 | 913.00 | 913.25 | 913.50 | 913.75 |
| CUC | 914.00 | 914.25 | 914.50 | 914.75 | 915.00 | 915.25 | 915.50 | 915.75 |
| CUD | 916.00 | 916.25 | 916.50 | 916.75 | 917.00 | 917.25 | 917.50 | 917.75 |
| CUE | 918.00 | 918.25 | 918.50 | 918.75 | 919.00 | 919.25 | 919.50 | 919.75 |
| CUF | 920.00 | 920.25 | 920.50 | 920.75 | 921.00 | 921.25 | 921.50 | 921.75 |
| CUG | 922.00 | 922.25 | 922.50 | 922.75 | 923.00 | 923.25 | 923.50 | 923.75 |
| CUH | 924.00 | 924.25 | 924.50 | 924.75 | 925.00 | 925.25 | 925.50 | 925.75 |
| CUI | 926.00 | 926.25 | 926.50 | 926.75 | 927.00 | 927.25 | 927.50 | 927.75 |
| CUS | 928.00 | 928.25 | 928.50 | 928.75 | 929.00 | 929.25 | 929.50 | 929.75 |
| CUT | 930.00 | 930.25 | 930.50 | 930.75 | 931.00 | 931.25 | 931.50 | 931.75 |
| CUU | 932.00 | 932.25 | 932.50 | 932.75 | 933.00 | 933.25 | 933.50 | 933.75 |
| CUV | 934.00 | 934.25 | 934.50 | 934.75 | 935.00 | 935.25 | 935.50 | 935.75 |
| CUW | 936.00 | 936.25 | 936.50 | 936.75 | 937.00 | 937.25 | 937.50 | 937.75 |
| CUX | 938.00 | 938.25 | 938.50 | 938.75 | 939.00 | 939.25 | 939.50 | 939.75 |
| CUY | 940.00 | 940.25 | 940.50 | 940.75 | 941.00 | 941.25 | 941.50 | 941.75 |
| CUZ | 942.00 | 942.25 | 942.50 | 942.75 | 943.00 | 943.25 | 943.50 | 943.75 |
| CVA | 944.00 | 944.25 | 944.50 | 944.75 | 945.00 | 945.25 | 945.50 | 945.75 |
| CVB | 946.00 | 946.25 | 946.50 | 946.75 | 947.00 | 947.25 | 947.50 | 947.75 |
| CVC | 948.00 | 948.25 | 948.50 | 948.75 | 949.00 | 949.25 | 949.50 | 949.75 |
| CVD | 950.00 | 950.25 | 950.50 | 950.75 | 951.00 | 951.25 | 951.50 | 951.75 |
| CVE | 952.00 | 952.25 | 952.50 | 952.75 | 953.00 | 953.25 | 953.50 | 953.75 |
| CVF | 954.00 | 954.25 | 954.50 | 954.75 | 955.00 | 955.25 | 955.50 | 955.75 |
| CVG | 956.00 | 956.25 | 956.50 | 956.75 | 957.00 | 957.25 | 957.50 | 957.75 |
| CVH | 958.00 | 958.25 | 958.50 | 958.75 | 959.00 | 959.25 | 959.50 | 959.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

COUNTS VS CPS

PAGE 14

CPS

|     | S       | U       | P       | M       | C       | K       | G       | O       |
|-----|---------|---------|---------|---------|---------|---------|---------|---------|
| CDS | 960.00  | 960.25  | 960.50  | 960.75  | 961.00  | 961.25  | 961.50  | 961.75  |
| CDU | 962.00  | 962.25  | 962.50  | 962.75  | 963.00  | 963.25  | 963.50  | 963.75  |
| CDV | 964.00  | 964.25  | 964.50  | 964.75  | 965.00  | 965.25  | 965.50  | 965.75  |
| CDW | 966.00  | 966.25  | 966.50  | 966.75  | 967.00  | 967.25  | 967.50  | 967.75  |
| CDX | 968.00  | 968.25  | 968.50  | 968.75  | 969.00  | 969.25  | 969.50  | 969.75  |
| CDY | 970.00  | 970.25  | 970.50  | 970.75  | 971.00  | 971.25  | 971.50  | 971.75  |
| CDZ | 972.00  | 972.25  | 972.50  | 972.75  | 973.00  | 973.25  | 973.50  | 973.75  |
| CEA | 974.00  | 974.25  | 974.50  | 974.75  | 975.00  | 975.25  | 975.50  | 975.75  |
| CEB | 976.00  | 976.25  | 976.50  | 976.75  | 977.00  | 977.25  | 977.50  | 977.75  |
| CEC | 978.00  | 978.25  | 978.50  | 978.75  | 979.00  | 979.25  | 979.50  | 979.75  |
| CED | 980.00  | 980.25  | 980.50  | 980.75  | 981.00  | 981.25  | 981.50  | 981.75  |
| CEE | 982.00  | 982.25  | 982.50  | 982.75  | 983.00  | 983.25  | 983.50  | 983.75  |
| CEF | 984.00  | 984.25  | 984.50  | 984.75  | 985.00  | 985.25  | 985.50  | 985.75  |
| CEG | 986.00  | 986.25  | 986.50  | 986.75  | 987.00  | 987.25  | 987.50  | 987.75  |
| CEH | 988.00  | 988.25  | 988.50  | 988.75  | 989.00  | 989.25  | 989.50  | 989.75  |
| CEI | 990.00  | 990.25  | 990.50  | 990.75  | 991.00  | 991.25  | 991.50  | 991.75  |
| CEJ | 992.00  | 992.25  | 992.50  | 992.75  | 993.00  | 993.25  | 993.50  | 993.75  |
| CEK | 994.00  | 994.25  | 994.50  | 994.75  | 995.00  | 995.25  | 995.50  | 995.75  |
| CEL | 996.00  | 996.25  | 996.50  | 996.75  | 997.00  | 997.25  | 997.50  | 997.75  |
| CEM | 998.00  | 998.25  | 998.50  | 998.75  | 999.00  | 999.25  | 999.50  | 999.75  |
| CEN | 1000.00 | 1000.25 | 1000.50 | 1000.75 | 1001.00 | 1001.25 | 1001.50 | 1001.75 |
| CEO | 1002.00 | 1002.25 | 1002.50 | 1002.75 | 1003.00 | 1003.25 | 1003.50 | 1003.75 |
| CEP | 1004.00 | 1004.25 | 1004.50 | 1004.75 | 1005.00 | 1005.25 | 1005.50 | 1005.75 |
| CEQ | 1006.00 | 1006.25 | 1006.50 | 1006.75 | 1007.00 | 1007.25 | 1007.50 | 1007.75 |
| CER | 1008.00 | 1008.25 | 1008.50 | 1008.75 | 1009.00 | 1009.25 | 1009.50 | 1009.75 |
| CES | 1010.00 | 1010.25 | 1010.50 | 1010.75 | 1011.00 | 1011.25 | 1011.50 | 1011.75 |
| CEU | 1012.00 | 1012.25 | 1012.50 | 1012.75 | 1013.00 | 1013.25 | 1013.50 | 1013.75 |
| CEV | 1014.00 | 1014.25 | 1014.50 | 1014.75 | 1015.00 | 1015.25 | 1015.50 | 1015.75 |
| CEW | 1016.00 | 1016.25 | 1016.50 | 1016.75 | 1017.00 | 1017.25 | 1017.50 | 1017.75 |
| CEx | 1018.00 | 1018.25 | 1018.50 | 1018.75 | 1019.00 | 1019.25 | 1019.50 | 1019.75 |
| CEY | 1020.00 | 1020.25 | 1020.50 | 1020.75 | 1021.00 | 1021.25 | 1021.50 | 1021.75 |
| CEZ | 1022.00 | 1022.25 | 1022.50 | 1022.75 | 1023.00 | 1023.25 | 1023.50 | 1023.75 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

```

03711777 SCOPE 3.4.4 * CDC468A A.F.G.L.
08.30.22.COR002J FROM MFA
08.30.22.2P 00000256 WORDS - FILE INPUT , DC *
08.30.22.COR0. 2036 CORDELLA
08.30.23.
08.30.25.FTN.SL.
08.30.32. .159 CP SECONDS COMPILATION TIME
08.30.32.LGO.
08.30.33. STOP
08.30.41. 1.159 CP SECONDS EXECUTION TIME
08.30.41.CP 00003312 WORDS - FILE OUTPUT , DC LC
08.30.41.MS 7168 WORDS ( 10762 MAX USED)
08.30.41.CPA 1.826 SEC.
08.30.41.IO .923 SEC.
08.30.41.TM 31.869 RMS.
08.30.41.SS COST OF JOB .078
08.30.41.PP COST OF JOB .078
08.30.41.EJ END OF JOB, **
08.30.41.EJ END OF JOB, **

***** COR002J //// END OF LIST ////
***** COR002J //// END OF LIST ////

```

## Appendix G

### Temperature Program

#### G1. GENERAL

This program produces a dictionary to convert coded data to degrees Celsius. It operates on the number of counts produced in two sec by an oscillator whose frequency is a function of temperature.

##### G1.1 The Algorithm

Since the thermistor resistance vs temperature is a nonlinear function, an  $n$ th order polynomial is fit to the data over a specified interval of datum points. It was determined empirically that a fourth-order equation fit over four points works very well. The order and interval are entered on data card 1 which precedes the temperature data.

##### G1.2 The Output

This discussion is keyed to a typical printout which is photo reduced and printed in its entirety at the end of this appendix. Following the identifier cover sheet are five pages of computer program. The comment cards explain the details of data entry. After the memory map is the data exactly as on the data cards. The 8 in column 1 of the last card is a flag which says there are no more data sets to follow. This flag works because the counts are entered as octal numbers; eights and nines do not exist in that number field. The next page is the program documenting how

you told it to process the data and how many datum points were read. Thirteen pages of dictionary, formulated to fit an  $8 \times 10\text{-}1/2$  in. binder, follow. The program prints full pages extrapolated from the data. Therefore, this dictionary begins at  $-80.0^{\circ}\text{C}$  to  $+20.0^{\circ}\text{C}$ . An error table showing deviations from the entered datum points concludes the requested printout. Negative zeros indicate that zero was being approached from the negative side and the error is smaller than  $-0.1^{\circ}\text{C}$ . Date, various computer times, and cost are documented on the last page. This dictionary is valid until changes are made in the encoder or thermistor.

### G1.3 The Input

The count of events occurring during the two sec encoder sample period which, is the program input, was obtained by terminating the encoder with a simulated thermistor and recording the code vs temperature. The simulated thermistor was an 11 position resistance box which was set to the thermistor resistance  $\pm 0.1$  percent for each of the 11 temperatures  $-80^{\circ}\text{C}$ ,  $-70^{\circ}\text{C}$ , ...,  $+20^{\circ}\text{C}$ . The count was derived from the code. This technique was used to check the accuracy of the PR-3 flowmeter system temperatures and is documented in Reference 18.

GCFD-20  
GCFD-20  
GCFD-20  
GCFD-20  
GCFD-20  
GCFD-20  
GCFD-20  
GCFD-20  
GCFD-20  
GCFD-20

[illegible][illegible]

35  
35  
35  
35  
35  
35

FTIR: 4.0, 5.4, 1.0

PROGRAM THERM 74/74 OPT=1

17215

147

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PROGRAM THERM 7/4/74 OPT=1

115

STOP  
END

FTN - 4-1-

SUBROUTINE COEF 7474 OPT=1

```

1  SUBROUTINE COEF(J)
   COMMON INT,INT2,IORDR,JORDR,N,KC,NC,ND,XD,XG,
   1 Y(20),COUNTS(20),TSTAR(20),G(2)
   DIMENSION DATI(100),WORK(20)
   IF(J+INT2-GT,N) RETURN
   J= J+1
   K1= J-INT2
   K2= J-INT2-1
   CALL PMOVE(COUNTS,K1,K2,DATI,1)
   CALL PMOVE(T,K1,K2,DATI,INT+1)
   DATI(2*INT+1)= -1
   JORDR= IORDR
   CALL APCH(DATI,INT,JORDR,XD,XG,WORK,1,5)
   CALL APFS(WORK,JORDR,1,5,XG,ND,XG,701,1,5)
   I= JORDR*(JORDR-1)/2+1
   CALL PMOVE(WORK,1,I,JORDR-1,0,1)
   CALL CMPS(TSTAR(J),COUNTS(J)*XD+YG,C,JORDR)
   NC=ND- IFIX(COUNTS(J))
   RETURN
   END

```

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

1

146

10/11/77 10:20:37

10/11/77 10:20:37

FTN 5414

OPT=1

74/74

SUBROUTINE RHOVE

```
1  SUBROUTINE RHOVE(X,N1,N2,Y,M1)
   DIMENSION X(1),Y(1)
   L1= M1
   DO 5 I= M1,N2
     Y(L1)= X(I)
     L1= L1+1
   5  RETURN
   END
```

LOAD MAP - CNPS

FMA OF THE LOAD 111  
LWA+1 OF THE LOAD 22534  
TRANSFER ADDRESS -- THERM 5035

CYBER LOADER 1 1-420

05/11/77 09:25:00

436

PROGRAM AND BLOCK ASSIGNMENTS.

| BLOCK     | ADDRESS | LENGTH | FILE       | DATE     | PROCESS | PER LEVEL | MARKMAP | COMMENTS                             |
|-----------|---------|--------|------------|----------|---------|-----------|---------|--------------------------------------|
| CNPS      | 111     | 70     | INPUT      | 04/26/74 | FTN     | 1.1       | 0374    | 0374                                 |
| APPS      | 201     | 252    | INPUT      | 04/26/74 | FTN     | 1.1       | 0374    | 0374                                 |
| APCH      | 453     | 251    | INPUT      | 04/26/74 | FTN     | 1.1       | 0374    | 0374                                 |
| THEPM     | 724     | 4735   | LGO        | 03/11/77 | FTN     | 1.1       | 0374    | 0374                                 |
| COFF      | 5661    | 665    | LGO        | 03/11/77 | FTN     | 1.1       | 0374    | 0374                                 |
| RMVE      | 6946    | 23     | LGO        | 03/11/77 | FTN     | 1.1       | 0374    | 0374                                 |
| /FOL.C./  | 6571    | 23     | LGO        | 03/11/77 | FTN     | 1.1       | 0374    | 0374                                 |
| /O8.10./  | 6614    | 131    | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON SUBROUTINE AND INITIALIZATION |
| COMIO=    | 6745    | 64     | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | FCL INITIALIZATION ROUTINE           |
| QENTRY=   | 6745    | 0      | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | INITIALIZE FUNCTIONS                 |
| FECKSY=   | 7031    | 41     | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON FORTRAN INPUT SUB             |
| FLFOU=    | 7072    | 310    | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | FORTRAN INPUT INITIALIZATION         |
| FORSYS=   | 7402    | 601    | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| INCOM=    | 10203   | 277    | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | FCL INITIALIZATION ROUTINE           |
| INPC=     | 10502   | 169    | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| KODR=     | 10662   | 456    | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | FCL INITIALIZATION ROUTINE           |
| OUTCOM=   | 11340   | 154    | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| GOHRE=    | 11514   | 14     | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| ITOF=     | 11530   | 16     | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| SORT      | 11546   | 43     | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| SYS=1ST   | 11611   | 62     | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| FLTN=     | 11673   | 154    | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| FMTAP=    | 12047   | 352    | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| FORTH=    | 12421   | 16     | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| CFIT=     | 12437   | 42     | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| WRKER=    | 12501   | 406    | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| OUTC=     | 13107   | 172    | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| SVSIO=    | 13381   | 1      | SL-FORTRAN | 05/11/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /CON.RM/  | 13302   | 6      | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /O8.RM/   | 13310   | 40     | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /ADR.RM/  | 13350   | 10     | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /OVE.RM/  | 13360   | 64     | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| MCT.RM    | 13444   | 233    | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /JMS.RM/  | 13677   | 11     | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /MNC.RM/  | 13710   | 3      | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /OES.FO/  | 13743   | 1      | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /OEN.FO/  | 13714   | 7      | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /OEN.RM   | 13723   | 235    | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /TEPM.RM/ | 14160   | 1      | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /PUT.FO/  | 14161   | 7      | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| PUT.SQ    | 14170   | 1362   | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /CLS.FO/  | 14552   | 260    | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /CLSF.FO/ | 16032   | 7      | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /CLSF.RM  | 16041   | 23     | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |
| /GET.BT/  | 16064   | 5      | SL-SYSIO   | 05/28/76 | COMPASS | 3.1       | 75125   | COMMON INPUT FORTRAN SUB             |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

146

05/11/77 09:30:40

CV922 LOADER 1.1-42

LOAD MAP - CNPS

|           |       |      |            |                  |          |
|-----------|-------|------|------------|------------------|----------|
| BIRT.SQ   | 16071 | 114  | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| MEOM.SQ   | 16205 | 182  | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| /SKFL.FO/ | 16367 | 7    |            |                  |          |
| SNFL.SQ   | 16366 | 47   | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| ERR.RM    | 16425 | 404  | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| CHMR.SQ   | 17031 | 7    | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| OSUR.RM   | 17042 | 65   | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| CPEN.SQ   | 17125 | 282  | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| OPEX.SQ   | 17407 | 14   | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| /POT.RT/  | 17423 | 11   |            |                  |          |
| ALCN.RM   | 17434 | 42   | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| CLSF.SQ   | 17476 | 132  | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| /CLSV.FO/ | 17630 | 7    |            |                  |          |
| CLSV.SQ   | 17637 | 123  | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| /REM.FO/  | 17762 | 7    |            |                  |          |
| REM.SQ    | 17771 | 31   | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| /GET.FO/  | 20022 | 7    |            |                  |          |
| /GET.RT/  | 20831 | 11   |            |                  |          |
| GET.SQ    | 20842 | 1035 | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| Z.SR      | 21077 | 101  | SL-SYSIO   | 05/28/76 COMPASS | 3. 75125 |
| FSQ.SQ    | 21200 | 106  | SL-SYSIO   | 05/26/76 COMPASS | 3. 75125 |
| SYS.RM    | 21306 | 37   | SL-NUCLEUS | 03/29/76 COMPASS | 3. 75125 |
| //        | 21345 | 1167 |            |                  |          |

PROCESS SYSTEM REQUEST

31 TABL- NOV.5

34000 CM STORAGE USED

569 CP SECONDS

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

86-4-40831J1 27 MAR 76  
00451 -60.0000  
00652 -70.0000  
01115 -60.0000  
01536 -50.0000  
02315 -40.0000  
03121 -30.0000  
04074 -20.0000  
04735 -10.0000  
05506 0.0000  
06151 10.0000  
06503 20.0000  
8+\*\*\* -0.0000

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

TEMPERATURE INPUT AS DEGREES CENTIGRADE  
TEMPERATURE OUTPUT AS DEGREES CENTIGRADE  
ORDER READ AS 4  
INTERVAL READ AS 4  
N IS 11  
INTERVAL USED IS 4

THERMISTOR CALIBRATION RESULTS S/N U083141 DATE 27 MAR 76 PAGE 1

TEMPERATURE IN DEGREES CENTIGRADE

|     | S     | U     | R     | M     | O     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| SOS | -84.8 | -84.7 | -84.5 | -84.4 | -84.3 | -84.2 | -84.1 | -83.9 |
| SOU | -82.8 | -82.7 | -82.6 | -82.5 | -82.4 | -82.3 | -82.1 | -82.0 |
| SOK | -81.9 | -81.8 | -81.7 | -81.6 | -81.5 | -81.4 | -81.3 | -81.1 |
| SOM | -81.0 | -80.9 | -80.8 | -80.7 | -80.6 | -80.5 | -80.3 | -80.2 |
| SOD | -80.1 | -80.0 | -79.9 | -79.8 | -79.7 | -79.6 | -79.5 | -79.4 |
| SOK | -79.2 | -79.1 | -79.0 | -78.9 | -78.8 | -78.7 | -78.6 | -78.5 |
| SOG | -78.4 | -78.3 | -78.2 | -78.1 | -78.0 | -77.9 | -77.8 | -77.7 |
| SOS | -77.6 | -77.5 | -77.4 | -77.3 | -77.2 | -77.1 | -77.0 | -76.9 |
| SOU | -76.8 | -76.7 | -76.6 | -76.5 | -76.4 | -76.3 | -76.2 | -76.1 |
| SOK | -76.0 | -75.9 | -75.8 | -75.7 | -75.6 | -75.5 | -75.4 | -75.3 |
| SOM | -75.3 | -75.2 | -75.1 | -75.0 | -74.9 | -74.8 | -74.7 | -74.6 |
| SOD | -74.5 | -74.4 | -74.3 | -74.2 | -74.1 | -74.0 | -73.9 | -73.8 |
| SOK | -73.8 | -73.7 | -73.6 | -73.5 | -73.4 | -73.3 | -73.2 | -73.1 |
| SOG | -73.1 | -73.0 | -72.9 | -72.8 | -72.7 | -72.6 | -72.5 | -72.4 |
| SOS | -72.4 | -72.3 | -72.2 | -72.1 | -72.0 | -71.9 | -71.8 | -71.7 |
| SOU | -71.6 | -71.5 | -71.4 | -71.3 | -71.2 | -71.1 | -71.0 | -70.9 |
| SOK | -70.8 | -70.7 | -70.6 | -70.5 | -70.4 | -70.3 | -70.2 | -70.1 |
| SOM | -69.9 | -69.8 | -69.7 | -69.6 | -69.5 | -69.4 | -69.3 | -69.2 |
| SOD | -69.3 | -69.2 | -69.1 | -69.0 | -68.9 | -68.8 | -68.7 | -68.6 |
| SOK | -68.8 | -68.7 | -68.6 | -68.5 | -68.4 | -68.3 | -68.2 | -68.1 |
| SOG | -68.2 | -68.1 | -68.0 | -67.9 | -67.8 | -67.7 | -67.6 | -67.5 |
| SOS | -67.7 | -67.6 | -67.5 | -67.4 | -67.3 | -67.2 | -67.1 | -67.0 |
| SOU | -67.2 | -67.1 | -67.0 | -66.9 | -66.8 | -66.7 | -66.6 | -66.5 |
| SOK | -66.7 | -66.6 | -66.5 | -66.4 | -66.3 | -66.2 | -66.1 | -66.0 |
| SOM | -66.2 | -66.1 | -66.0 | -65.9 | -65.8 | -65.7 | -65.6 | -65.5 |
| SOD | -65.7 | -65.6 | -65.5 | -65.4 | -65.3 | -65.2 | -65.1 | -65.0 |
| SOK | -65.2 | -65.1 | -65.0 | -64.9 | -64.8 | -64.7 | -64.6 | -64.5 |
| SOG | -64.8 | -64.7 | -64.6 | -64.5 | -64.4 | -64.3 | -64.2 | -64.1 |
| SOS | -64.3 | -64.2 | -64.1 | -64.0 | -63.9 | -63.8 | -63.7 | -63.6 |
| SOU | -63.9 | -63.8 | -63.7 | -63.6 | -63.5 | -63.4 | -63.3 | -63.2 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

—THERMISTOR CALIBRATION RESULTS S/N W031J1 DATE 27 MAR 76 PAGE 2

TEMPERATURE IN DEGREES CENTIGRADE

|     | S     | T     | R     | M     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| USS | -63.5 | -63.4 | -63.4 | -63.3 | -63.3 | -63.2 | -63.2 | -63.1 |
| USU | -63.1 | -63.0 | -62.9 | -62.9 | -62.9 | -62.8 | -62.8 | -62.7 |
| USV | -62.7 | -62.6 | -62.6 | -62.5 | -62.5 | -62.5 | -62.4 | -62.4 |
| USW | -62.3 | -62.3 | -62.2 | -62.2 | -62.1 | -62.1 | -62.0 | -61.9 |
| USX | -61.9 | -61.8 | -61.8 | -61.8 | -61.8 | -61.7 | -61.7 | -61.6 |
| USK | -61.6 | -61.5 | -61.5 | -61.4 | -61.4 | -61.4 | -61.3 | -61.3 |
| US6 | -61.2 | -61.2 | -61.1 | -61.1 | -61.0 | -61.0 | -60.9 | -60.9 |
| USO | -60.9 | -60.8 | -60.8 | -60.7 | -60.7 | -60.6 | -60.6 | -60.5 |
| UIS | -60.5 | -60.5 | -60.5 | -60.4 | -60.4 | -60.3 | -60.3 | -60.2 |
| UIU | -60.2 | -60.1 | -60.1 | -60.1 | -60.0 | -60.0 | -59.9 | -59.9 |
| UIR | -59.9 | -59.8 | -59.8 | -59.7 | -59.7 | -59.6 | -59.6 | -59.5 |
| UIW | -59.5 | -59.5 | -59.4 | -59.4 | -59.3 | -59.3 | -59.2 | -59.2 |
| UID | -59.1 | -59.1 | -59.1 | -59.0 | -59.0 | -58.9 | -58.9 | -58.9 |
| UIK | -58.8 | -58.7 | -58.7 | -58.7 | -58.6 | -58.6 | -58.5 | -58.5 |
| UIG | -58.4 | -58.4 | -58.4 | -58.3 | -58.3 | -58.2 | -58.2 | -58.1 |
| UIO | -58.1 | -58.1 | -58.0 | -58.0 | -57.9 | -57.9 | -57.8 | -57.7 |
| URS | -57.8 | -57.7 | -57.7 | -57.6 | -57.6 | -57.5 | -57.5 | -57.4 |
| URU | -57.4 | -57.4 | -57.3 | -57.3 | -57.3 | -57.2 | -57.2 | -57.1 |
| URR | -57.1 | -57.1 | -57.0 | -57.0 | -56.9 | -56.9 | -56.9 | -56.8 |
| URW | -56.8 | -56.7 | -56.7 | -56.7 | -56.6 | -56.6 | -56.5 | -56.5 |
| URD | -56.5 | -56.4 | -56.4 | -56.3 | -56.3 | -56.3 | -56.2 | -56.2 |
| URK | -56.1 | -56.1 | -56.1 | -56.0 | -56.0 | -55.9 | -55.9 | -55.8 |
| UR6 | -55.8 | -55.8 | -55.8 | -55.7 | -55.7 | -55.6 | -55.6 | -55.5 |
| URO | -55.5 | -55.5 | -55.4 | -55.4 | -55.4 | -55.3 | -55.3 | -55.2 |
| UNS | -55.2 | -55.1 | -55.1 | -55.1 | -55.0 | -55.0 | -55.0 | -54.9 |
| UNU | -54.9 | -54.9 | -54.9 | -54.8 | -54.8 | -54.7 | -54.7 | -54.7 |
| UNR | -54.6 | -54.6 | -54.6 | -54.5 | -54.5 | -54.5 | -54.4 | -54.4 |
| UNW | -54.3 | -54.3 | -54.3 | -54.2 | -54.2 | -54.2 | -54.1 | -54.1 |
| UND | -54.1 | -54.0 | -54.0 | -54.0 | -53.9 | -53.9 | -53.8 | -53.8 |
| UNK | -53.8 | -53.7 | -53.7 | -53.7 | -53.6 | -53.6 | -53.5 | -53.5 |
| UNG | -53.5 | -53.5 | -53.4 | -53.4 | -53.4 | -53.3 | -53.3 | -53.2 |
| UNO | -53.2 | -53.2 | -53.2 | -53.1 | -53.1 | -53.1 | -53.0 | -53.0 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

—THERMISTOR CALIBRATION RESULTS S/N U0831J1 DATE 27 MAR 75 PAGE 3

TEMPERATURE IN DEGREES CENTIGRADE

|     | S     | U     | R     | M     | D     | K     | G     | U     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| U03 | -53.0 | -52.9 | -52.9 | -52.9 | -52.8 | -52.8 | -52.8 | -52.7 |
| U04 | -52.7 | -52.7 | -52.6 | -52.6 | -52.6 | -52.5 | -52.5 | -52.5 |
| U05 | -52.4 | -52.4 | -52.4 | -52.3 | -52.3 | -52.3 | -52.2 | -52.2 |
| U06 | -52.2 | -52.1 | -52.1 | -52.0 | -52.0 | -52.0 | -51.9 | -51.9 |
| U07 | -51.9 | -51.9 | -51.8 | -51.8 | -51.8 | -51.7 | -51.7 | -51.7 |
| U08 | -51.6 | -51.6 | -51.6 | -51.5 | -51.5 | -51.5 | -51.4 | -51.4 |
| U09 | -51.4 | -51.4 | -51.3 | -51.3 | -51.3 | -51.2 | -51.2 | -51.2 |
| U10 | -51.1 | -51.1 | -51.1 | -51.0 | -51.0 | -51.0 | -50.9 | -50.9 |
| U11 | -50.9 | -50.9 | -50.8 | -50.8 | -50.8 | -50.7 | -50.7 | -50.7 |
| U12 | -50.7 | -50.6 | -50.6 | -50.6 | -50.5 | -50.5 | -50.5 | -50.4 |
| U13 | -50.4 | -50.4 | -50.4 | -50.3 | -50.3 | -50.3 | -50.2 | -50.2 |
| U14 | -50.2 | -50.1 | -50.1 | -50.1 | -50.1 | -50.1 | -50.0 | -50.0 |
| U15 | -49.9 | -49.9 | -49.9 | -49.8 | -49.8 | -49.8 | -49.7 | -49.7 |
| U16 | -49.7 | -49.7 | -49.6 | -49.6 | -49.6 | -49.5 | -49.5 | -49.5 |
| U17 | -49.4 | -49.4 | -49.4 | -49.3 | -49.3 | -49.3 | -49.2 | -49.2 |
| U18 | -49.2 | -49.2 | -49.1 | -49.1 | -49.1 | -49.1 | -49.0 | -49.0 |
| U19 | -48.9 | -48.9 | -48.9 | -48.8 | -48.8 | -48.8 | -48.7 | -48.7 |
| U20 | -48.7 | -48.7 | -48.6 | -48.6 | -48.6 | -48.5 | -48.5 | -48.5 |
| U21 | -48.5 | -48.4 | -48.4 | -48.4 | -48.3 | -48.3 | -48.3 | -48.2 |
| U22 | -48.2 | -48.2 | -48.2 | -48.1 | -48.1 | -48.1 | -48.0 | -48.0 |
| U23 | -48.0 | -47.9 | -47.9 | -47.9 | -47.9 | -47.8 | -47.8 | -47.8 |
| U24 | -47.7 | -47.7 | -47.7 | -47.6 | -47.6 | -47.6 | -47.5 | -47.5 |
| U25 | -47.5 | -47.5 | -47.4 | -47.4 | -47.4 | -47.4 | -47.3 | -47.3 |
| U26 | -47.3 | -47.2 | -47.2 | -47.2 | -47.1 | -47.1 | -47.1 | -47.1 |
| U27 | -47.0 | -47.0 | -47.0 | -46.9 | -46.9 | -46.9 | -46.8 | -46.8 |
| U28 | -46.8 | -46.8 | -46.7 | -46.7 | -46.7 | -46.7 | -46.6 | -46.6 |
| U29 | -46.6 | -46.5 | -46.5 | -46.5 | -46.4 | -46.4 | -46.4 | -46.4 |
| U30 | -46.3 | -46.3 | -46.3 | -46.3 | -46.2 | -46.2 | -46.2 | -46.1 |
| U31 | -46.1 | -46.1 | -46.1 | -46.0 | -46.0 | -46.0 | -46.0 | -46.0 |
| U32 | -45.9 | -45.9 | -45.9 | -45.8 | -45.8 | -45.8 | -45.7 | -45.7 |
| U33 | -45.7 | -45.6 | -45.6 | -45.6 | -45.6 | -45.5 | -45.5 | -45.5 |
| U34 | -45.4 | -45.4 | -45.4 | -45.4 | -45.3 | -45.3 | -45.3 | -45.3 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

THERMISTOR CALIBRATION RESULTS S/N U0831J1 DATE 27 MAR 76 PAGE 4

TEMPERATURE IN DEGREES CENTIGRADE

|     | S     | U     | R     | M     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| RSS | -45.2 | -45.2 | -45.1 | -45.1 | -45.1 | -45.1 | -45.1 | -45.1 |
| RSU | -45.0 | -45.0 | -44.9 | -44.9 | -44.9 | -44.9 | -44.9 | -44.9 |
| RSV | -44.8 | -44.8 | -44.7 | -44.7 | -44.7 | -44.7 | -44.7 | -44.7 |
| RSW | -44.6 | -44.6 | -44.5 | -44.5 | -44.5 | -44.5 | -44.5 | -44.5 |
| RSD | -44.4 | -44.4 | -44.3 | -44.3 | -44.3 | -44.3 | -44.3 | -44.3 |
| RSE | -44.2 | -44.2 | -44.1 | -44.1 | -44.1 | -44.1 | -44.1 | -44.1 |
| RSF | -44.0 | -44.0 | -43.9 | -43.9 | -43.9 | -43.9 | -43.9 | -43.9 |
| RSG | -43.8 | -43.8 | -43.7 | -43.7 | -43.7 | -43.7 | -43.7 | -43.7 |
| RSH | -43.6 | -43.6 | -43.5 | -43.5 | -43.5 | -43.5 | -43.5 | -43.5 |
| RSI | -43.4 | -43.4 | -43.3 | -43.3 | -43.3 | -43.3 | -43.3 | -43.3 |
| RSJ | -43.2 | -43.2 | -43.1 | -43.1 | -43.1 | -43.1 | -43.1 | -43.1 |
| RSK | -43.0 | -43.0 | -42.9 | -42.9 | -42.9 | -42.9 | -42.9 | -42.9 |
| RSL | -42.8 | -42.8 | -42.7 | -42.7 | -42.7 | -42.7 | -42.7 | -42.7 |
| RSM | -42.6 | -42.6 | -42.5 | -42.5 | -42.5 | -42.5 | -42.5 | -42.5 |
| RSN | -42.4 | -42.4 | -42.3 | -42.3 | -42.3 | -42.3 | -42.3 | -42.3 |
| RSO | -42.2 | -42.2 | -42.1 | -42.1 | -42.1 | -42.1 | -42.1 | -42.1 |
| RSP | -42.0 | -42.0 | -41.9 | -41.9 | -41.9 | -41.9 | -41.9 | -41.9 |
| RSQ | -41.8 | -41.8 | -41.7 | -41.7 | -41.7 | -41.7 | -41.7 | -41.7 |
| RSR | -41.6 | -41.6 | -41.5 | -41.5 | -41.5 | -41.5 | -41.5 | -41.5 |
| RSU | -41.4 | -41.4 | -41.3 | -41.3 | -41.3 | -41.3 | -41.3 | -41.3 |
| RSV | -41.2 | -41.2 | -41.1 | -41.1 | -41.1 | -41.1 | -41.1 | -41.1 |
| RSW | -41.0 | -41.0 | -40.9 | -40.9 | -40.9 | -40.9 | -40.9 | -40.9 |
| RSX | -40.8 | -40.8 | -40.7 | -40.7 | -40.7 | -40.7 | -40.7 | -40.7 |
| RSY | -40.6 | -40.6 | -40.5 | -40.5 | -40.5 | -40.5 | -40.5 | -40.5 |
| RSS | -40.4 | -40.4 | -40.3 | -40.3 | -40.3 | -40.3 | -40.3 | -40.3 |
| RSU | -40.2 | -40.2 | -40.1 | -40.1 | -40.1 | -40.1 | -40.1 | -40.1 |
| RSV | -39.9 | -39.9 | -39.8 | -39.8 | -39.8 | -39.8 | -39.8 | -39.8 |
| RSW | -39.7 | -39.7 | -39.6 | -39.6 | -39.6 | -39.6 | -39.6 | -39.6 |
| RSD | -39.5 | -39.5 | -39.4 | -39.4 | -39.4 | -39.4 | -39.4 | -39.4 |
| RSE | -39.3 | -39.3 | -39.2 | -39.2 | -39.2 | -39.2 | -39.2 | -39.2 |
| RSF | -39.1 | -39.1 | -39.0 | -39.0 | -39.0 | -39.0 | -39.0 | -39.0 |
| RSG | -38.9 | -38.9 | -38.8 | -38.8 | -38.8 | -38.8 | -38.8 | -38.8 |
| RSH | -38.7 | -38.7 | -38.6 | -38.6 | -38.6 | -38.6 | -38.6 | -38.6 |
| RSI | -38.5 | -38.5 | -38.4 | -38.4 | -38.4 | -38.4 | -38.4 | -38.4 |
| RSJ | -38.3 | -38.3 | -38.2 | -38.2 | -38.2 | -38.2 | -38.2 | -38.2 |
| RSK | -38.1 | -38.1 | -38.0 | -38.0 | -38.0 | -38.0 | -38.0 | -38.0 |
| RSL | -37.9 | -37.9 | -37.8 | -37.8 | -37.8 | -37.8 | -37.8 | -37.8 |
| RSM | -37.7 | -37.7 | -37.6 | -37.6 | -37.6 | -37.6 | -37.6 | -37.6 |
| RSN | -37.5 | -37.5 | -37.4 | -37.4 | -37.4 | -37.4 | -37.4 | -37.4 |
| RSO | -37.3 | -37.3 | -37.2 | -37.2 | -37.2 | -37.2 | -37.2 | -37.2 |
| RSP | -37.1 | -37.1 | -37.0 | -37.0 | -37.0 | -37.0 | -37.0 | -37.0 |
| RSQ | -36.9 | -36.9 | -36.8 | -36.8 | -36.8 | -36.8 | -36.8 | -36.8 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

THEMISTOR CALIBRATION RESULTS S/N UH31J1 DATE 27 MAR 76 PAGE 5

TEMPERATURE IN DEGREES CENTIGRADE

|     | S     | T     | R     | M     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| RDS | -38.7 | -38.7 | -38.7 | -38.7 | -38.6 | -38.6 | -38.5 | -38.5 |
| ROU | -38.5 | -38.5 | -38.5 | -38.5 | -38.5 | -38.5 | -38.5 | -38.5 |
| ROR | -38.3 | -38.3 | -38.3 | -38.3 | -38.3 | -38.3 | -38.2 | -38.2 |
| ROB | -38.2 | -38.2 | -38.2 | -38.2 | -38.2 | -38.2 | -38.1 | -38.1 |
| RDB | -38.0 | -38.0 | -38.0 | -38.0 | -38.0 | -38.0 | -37.9 | -37.9 |
| RDK | -37.8 | -37.8 | -37.8 | -37.8 | -37.7 | -37.7 | -37.6 | -37.6 |
| RDE | -37.6 | -37.6 | -37.6 | -37.6 | -37.5 | -37.5 | -37.4 | -37.4 |
| RDO | -37.4 | -37.4 | -37.4 | -37.4 | -37.3 | -37.3 | -37.2 | -37.2 |
| RKS | -37.2 | -37.2 | -37.2 | -37.2 | -37.1 | -37.1 | -37.0 | -37.0 |
| RKU | -37.0 | -37.0 | -37.0 | -37.0 | -36.9 | -36.9 | -36.8 | -36.8 |
| RKR | -36.8 | -36.8 | -36.8 | -36.8 | -36.7 | -36.7 | -36.6 | -36.6 |
| RKM | -36.6 | -36.6 | -36.6 | -36.6 | -36.5 | -36.5 | -36.4 | -36.4 |
| RKO | -36.4 | -36.4 | -36.4 | -36.4 | -36.3 | -36.3 | -36.2 | -36.2 |
| RKG | -36.2 | -36.2 | -36.2 | -36.2 | -36.1 | -36.1 | -36.0 | -36.0 |
| RKH | -36.0 | -36.0 | -36.0 | -36.0 | -35.9 | -35.9 | -35.8 | -35.8 |
| RKD | -35.8 | -35.8 | -35.8 | -35.8 | -35.7 | -35.7 | -35.6 | -35.6 |
| RKE | -35.6 | -35.6 | -35.6 | -35.6 | -35.5 | -35.5 | -35.4 | -35.4 |
| RKF | -35.4 | -35.4 | -35.4 | -35.4 | -35.3 | -35.3 | -35.2 | -35.2 |
| RKG | -35.2 | -35.2 | -35.2 | -35.2 | -35.1 | -35.1 | -35.0 | -35.0 |
| RKH | -35.0 | -35.0 | -35.0 | -35.0 | -34.9 | -34.9 | -34.8 | -34.8 |
| RKI | -34.8 | -34.8 | -34.8 | -34.8 | -34.7 | -34.7 | -34.6 | -34.6 |
| RKJ | -34.6 | -34.6 | -34.6 | -34.6 | -34.5 | -34.5 | -34.4 | -34.4 |
| RKK | -34.4 | -34.4 | -34.4 | -34.4 | -34.3 | -34.3 | -34.2 | -34.2 |
| RKL | -34.2 | -34.2 | -34.2 | -34.2 | -34.1 | -34.1 | -34.0 | -34.0 |
| RKM | -34.0 | -34.0 | -34.0 | -34.0 | -33.9 | -33.9 | -33.8 | -33.8 |
| RKN | -33.8 | -33.8 | -33.8 | -33.8 | -33.7 | -33.7 | -33.6 | -33.6 |
| RKO | -33.6 | -33.6 | -33.6 | -33.6 | -33.5 | -33.5 | -33.4 | -33.4 |
| RKP | -33.4 | -33.4 | -33.4 | -33.4 | -33.3 | -33.3 | -33.2 | -33.2 |
| RKQ | -33.2 | -33.2 | -33.2 | -33.2 | -33.1 | -33.1 | -33.0 | -33.0 |
| RKR | -33.0 | -33.0 | -33.0 | -33.0 | -32.9 | -32.9 | -32.8 | -32.8 |
| RKS | -32.8 | -32.8 | -32.8 | -32.8 | -32.7 | -32.7 | -32.6 | -32.6 |
| RKT | -32.6 | -32.6 | -32.6 | -32.6 | -32.5 | -32.5 | -32.4 | -32.4 |
| RKU | -32.4 | -32.4 | -32.4 | -32.4 | -32.3 | -32.3 | -32.2 | -32.2 |
| RKV | -32.2 | -32.2 | -32.2 | -32.2 | -32.1 | -32.1 | -32.0 | -32.0 |
| RKW | -32.0 | -32.0 | -32.0 | -32.0 | -31.9 | -31.9 | -31.8 | -31.8 |
| RKX | -31.8 | -31.8 | -31.8 | -31.8 | -31.7 | -31.7 | -31.6 | -31.6 |
| RKY | -31.6 | -31.6 | -31.6 | -31.6 | -31.5 | -31.5 | -31.4 | -31.4 |
| RKZ | -31.4 | -31.4 | -31.4 | -31.4 | -31.3 | -31.3 | -31.2 | -31.2 |
| RLA | -31.2 | -31.2 | -31.2 | -31.2 | -31.1 | -31.1 | -31.0 | -31.0 |
| RLB | -31.0 | -31.0 | -31.0 | -31.0 | -30.9 | -30.9 | -30.8 | -30.8 |
| RLC | -30.8 | -30.8 | -30.8 | -30.8 | -30.7 | -30.7 | -30.6 | -30.6 |
| RLD | -30.6 | -30.6 | -30.6 | -30.6 | -30.5 | -30.5 | -30.4 | -30.4 |
| RLS | -30.4 | -30.4 | -30.4 | -30.4 | -30.3 | -30.3 | -30.2 | -30.2 |
| RLT | -30.2 | -30.2 | -30.2 | -30.2 | -30.1 | -30.1 | -30.0 | -30.0 |
| RLU | -30.0 | -30.0 | -30.0 | -30.0 | -29.9 | -29.9 | -29.8 | -29.8 |
| RLV | -29.8 | -29.8 | -29.8 | -29.8 | -29.7 | -29.7 | -29.6 | -29.6 |
| RLW | -29.6 | -29.6 | -29.6 | -29.6 | -29.5 | -29.5 | -29.4 | -29.4 |
| RLX | -29.4 | -29.4 | -29.4 | -29.4 | -29.3 | -29.3 | -29.2 | -29.2 |
| RLY | -29.2 | -29.2 | -29.2 | -29.2 | -29.1 | -29.1 | -29.0 | -29.0 |
| RLZ | -29.0 | -29.0 | -29.0 | -29.0 | -28.9 | -28.9 | -28.8 | -28.8 |
| RMA | -28.8 | -28.8 | -28.8 | -28.8 | -28.7 | -28.7 | -28.6 | -28.6 |
| RMB | -28.6 | -28.6 | -28.6 | -28.6 | -28.5 | -28.5 | -28.4 | -28.4 |
| RMC | -28.4 | -28.4 | -28.4 | -28.4 | -28.3 | -28.3 | -28.2 | -28.2 |
| RMD | -28.2 | -28.2 | -28.2 | -28.2 | -28.1 | -28.1 | -28.0 | -28.0 |
| RME | -28.0 | -28.0 | -28.0 | -28.0 | -27.9 | -27.9 | -27.8 | -27.8 |
| RMF | -27.8 | -27.8 | -27.8 | -27.8 | -27.7 | -27.7 | -27.6 | -27.6 |
| RMG | -27.6 | -27.6 | -27.6 | -27.6 | -27.5 | -27.5 | -27.4 | -27.4 |
| RMH | -27.4 | -27.4 | -27.4 | -27.4 | -27.3 | -27.3 | -27.2 | -27.2 |
| RMJ | -27.2 | -27.2 | -27.2 | -27.2 | -27.1 | -27.1 | -27.0 | -27.0 |
| RMK | -27.0 | -27.0 | -27.0 | -27.0 | -26.9 | -26.9 | -26.8 | -26.8 |
| RMN | -26.8 | -26.8 | -26.8 | -26.8 | -26.7 | -26.7 | -26.6 | -26.6 |
| RMQ | -26.6 | -26.6 | -26.6 | -26.6 | -26.5 | -26.5 | -26.4 | -26.4 |
| RMR | -26.4 | -26.4 | -26.4 | -26.4 | -26.3 | -26.3 | -26.2 | -26.2 |
| RMU | -26.2 | -26.2 | -26.2 | -26.2 | -26.1 | -26.1 | -26.0 | -26.0 |
| RMV | -26.0 | -26.0 | -26.0 | -26.0 | -25.9 | -25.9 | -25.8 | -25.8 |
| RMW | -25.8 | -25.8 | -25.8 | -25.8 | -25.7 | -25.7 | -25.6 | -25.6 |
| RMX | -25.6 | -25.6 | -25.6 | -25.6 | -25.5 | -25.5 | -25.4 | -25.4 |
| RMZ | -25.4 | -25.4 | -25.4 | -25.4 | -25.3 | -25.3 | -25.2 | -25.2 |
| RNA | -25.2 | -25.2 | -25.2 | -25.2 | -25.1 | -25.1 | -25.0 | -25.0 |
| RNB | -25.0 | -25.0 | -25.0 | -25.0 | -24.9 | -24.9 | -24.8 | -24.8 |
| RNC | -24.8 | -24.8 | -24.8 | -24.8 | -24.7 | -24.7 | -24.6 | -24.6 |
| RND | -24.6 | -24.6 | -24.6 | -24.6 | -24.5 | -24.5 | -24.4 | -24.4 |
| RNE | -24.4 | -24.4 | -24.4 | -24.4 | -24.3 | -24.3 | -24.2 | -24.2 |
| RNF | -24.2 | -24.2 | -24.2 | -24.2 | -24.1 | -24.1 | -24.0 | -24.0 |
| RNG | -24.0 | -24.0 | -24.0 | -24.0 | -23.9 | -23.9 | -23.8 | -23.8 |
| RNH | -23.8 | -23.8 | -23.8 | -23.8 | -23.7 | -23.7 | -23.6 | -23.6 |
| RNI | -23.6 | -23.6 | -23.6 | -23.6 | -23.5 | -23.5 | -23.4 | -23.4 |
| RNJ | -23.4 | -23.4 | -23.4 | -23.4 | -23.3 | -23.3 | -23.2 | -23.2 |
| RNK | -23.2 | -23.2 | -23.2 | -23.2 | -23.1 | -23.1 | -23.0 | -23.0 |
| RNL | -23.0 | -23.0 | -23.0 | -23.0 | -22.9 | -22.9 | -22.8 | -22.8 |
| RNM | -22.8 | -22.8 | -22.8 | -22.8 | -22.7 | -22.7 | -22.6 | -22.6 |
| RNO | -22.6 | -22.6 | -22.6 | -22.6 | -22.5 | -22.5 | -22.4 | -22.4 |
| RNP | -22.4 | -22.4 | -22.4 | -22.4 | -22.3 | -22.3 | -22.2 | -22.2 |
| RNQ | -22.2 | -22.2 | -22.2 | -22.2 | -22.1 | -22.1 | -22.0 | -22.0 |
| RNR | -22.0 | -22.0 | -22.0 | -22.0 | -21.9 | -21.9 | -21.8 | -21.8 |
| RNS | -21.8 | -21.8 | -21.8 | -21.8 | -21.7 | -21.7 | -21.6 | -21.6 |
| RNT | -21.6 | -21.6 | -21.6 | -21.6 | -21.5 | -21.5 | -21.4 | -21.4 |
| RNU | -21.4 | -21.4 | -21.4 | -21.4 | -21.3 | -21.3 | -21.2 | -21.2 |
| RNV | -21.2 | -21.2 | -21.2 | -21.2 | -21.1 | -21.1 | -21.0 | -21.0 |
| RNW | -21.0 | -21.0 | -21.0 | -21.0 | -20.9 | -20.9 | -20.8 | -20.8 |
| RNX | -20.8 | -20.8 | -20.8 | -20.8 | -20.7 | -20.7 | -20.6 | -20.6 |
| RNY | -20.6 | -20.6 | -20.6 | -20.6 | -20.5 | -20.5 | -20.4 | -20.4 |
| RNZ | -20.4 | -20.4 | -20.4 | -20.4 | -20.3 | -20.3 | -20.2 | -20.2 |
| ROA | -20.2 | -20.2 | -20.2 | -20.2 | -20.1 | -20.1 | -20.0 | -20.0 |
| ROB | -20.0 | -20.0 | -20.0 | -20.0 | -19.9 | -19.9 | -19.8 | -19.8 |
| ROC | -19.8 | -19.8 | -19.8 | -19.8 | -19.7 | -19.7 | -19.6 | -19.6 |
| ROD | -19.6 | -19.6 | -19.6 | -19.6 | -19.5 | -19.5 | -19.4 | -19.4 |
| ROE | -19.4 | -19.4 | -19.4 | -19.4 | -19.3 | -19.3 | -19.2 | -19.2 |
| ROF | -19.2 | -19.2 | -19.2 | -19.2 | -19.1 | -19.1 | -19.0 | -19.0 |
| ROG | -19.0 | -19.0 | -19.0 | -19.0 | -18.9 | -18.9 | -18.8 | -18.8 |
| ROH | -18.8 | -18.8 | -18.8 | -18.8 | -18.7 | -18.7 | -18.6 | -18.6 |
| ROI | -18.6 | -18.6 | -18.6 | -18.6 | -18.5 | -18.5 | -18.4 | -18.4 |
| ROJ | -18.4 | -18.4 | -18.4 | -18.4 | -18.3 | -18.3 | -18.2 | -18.2 |
| ROK | -18.2 | -18.2 | -18.2 | -18.2 | -18.1 | -18.1 | -18.0 | -18.0 |
| ROL | -18.0 | -18.0 | -18.0 | -18.0 | -17.9 | -17.9 | -17.8 | -17.8 |
| ROM | -17.8 | -17.8 | -17.8 | -17.8 | -17.7 | -17.7 | -17.6 | -17.6 |
| RON | -17.6 | -17.6 | -17.6 | -17.6 | -17.5 | -17.5 | -17.4 | -17.4 |
| ROO | -17.4 | -17.4 | -17.4 | -17.4 | -17.3 | -17.3 | -17.2 | -17.2 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

—THERMISTOR CALIBRATION RESULTS S/N UB31J1 DATE 27 MAR 76 PAGE 5

TEMPERATURE IN DEGREES CENTIGRAD

|     | S     | U     | R     | W     | O     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| MS  | -32.7 | -32.7 | -32.7 | -32.6 | -32.6 | -32.6 | -32.6 | -32.6 |
| MSU | -32.5 | -32.5 | -32.5 | -32.5 | -32.4 | -32.4 | -32.4 | -32.4 |
| MSV | -32.4 | -32.3 | -32.3 | -32.3 | -32.3 | -32.2 | -32.2 | -32.2 |
| MSW | -32.2 | -32.1 | -32.1 | -32.1 | -32.1 | -32.1 | -32.1 | -32.1 |
| MSD | -32.0 | -32.0 | -31.9 | -31.9 | -31.9 | -31.9 | -31.9 | -31.9 |
| MSK | -31.8 | -31.8 | -31.8 | -31.7 | -31.7 | -31.7 | -31.7 | -31.7 |
| MSG | -31.6 | -31.6 | -31.6 | -31.6 | -31.5 | -31.5 | -31.5 | -31.5 |
| MSO | -31.5 | -31.4 | -31.4 | -31.4 | -31.4 | -31.3 | -31.3 | -31.3 |
| MUS | -31.3 | -31.3 | -31.2 | -31.2 | -31.2 | -31.2 | -31.1 | -31.1 |
| MUU | -31.1 | -31.1 | -31.0 | -31.0 | -31.0 | -31.0 | -31.0 | -31.0 |
| MUR | -30.9 | -30.9 | -30.9 | -30.8 | -30.8 | -30.8 | -30.8 | -30.8 |
| MUN | -30.7 | -30.7 | -30.7 | -30.7 | -30.6 | -30.6 | -30.6 | -30.6 |
| MUD | -30.6 | -30.5 | -30.5 | -30.5 | -30.5 | -30.4 | -30.4 | -30.4 |
| MUK | -30.4 | -30.4 | -30.3 | -30.3 | -30.3 | -30.3 | -30.2 | -30.2 |
| MUG | -30.2 | -30.2 | -30.2 | -30.1 | -30.1 | -30.1 | -30.1 | -30.1 |
| MUO | -30.0 | -30.0 | -30.0 | -30.0 | -29.9 | -29.9 | -29.9 | -29.9 |
| MRS | -29.8 | -29.8 | -29.8 | -29.8 | -29.8 | -29.7 | -29.7 | -29.7 |
| MRI | -29.7 | -29.6 | -29.6 | -29.6 | -29.6 | -29.6 | -29.6 | -29.6 |
| MRR | -29.5 | -29.5 | -29.4 | -29.4 | -29.4 | -29.4 | -29.4 | -29.4 |
| MRI | -29.3 | -29.3 | -29.3 | -29.2 | -29.2 | -29.2 | -29.2 | -29.2 |
| MRI | -29.1 | -29.1 | -29.1 | -29.1 | -29.1 | -29.1 | -29.1 | -29.1 |
| MRI | -29.0 | -28.9 | -28.9 | -28.9 | -28.9 | -28.8 | -28.8 | -28.8 |
| MRI | -28.8 | -28.8 | -28.7 | -28.7 | -28.7 | -28.7 | -28.6 | -28.6 |
| MRI | -28.6 | -28.6 | -28.6 | -28.5 | -28.5 | -28.5 | -28.5 | -28.5 |
| MMS | -28.4 | -28.4 | -28.4 | -28.4 | -28.3 | -28.3 | -28.3 | -28.3 |
| MNU | -28.2 | -28.2 | -28.2 | -28.2 | -28.2 | -28.1 | -28.1 | -28.1 |
| MNR | -28.0 | -28.0 | -28.0 | -28.0 | -28.0 | -28.0 | -27.9 | -27.9 |
| MNV | -27.9 | -27.9 | -27.9 | -27.8 | -27.8 | -27.8 | -27.8 | -27.8 |
| MND | -27.7 | -27.7 | -27.7 | -27.7 | -27.6 | -27.6 | -27.6 | -27.6 |
| MNK | -27.5 | -27.5 | -27.5 | -27.5 | -27.5 | -27.4 | -27.4 | -27.4 |
| MNG | -27.4 | -27.3 | -27.3 | -27.3 | -27.3 | -27.2 | -27.2 | -27.2 |
| MNO | -27.2 | -27.2 | -27.1 | -27.1 | -27.1 | -27.1 | -27.1 | -27.1 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

THERMISTOR CALIBRATION RESULTS S/N UUR31J1 DATE 27 MAR 76 PAGE 7

TEMPERATURE IN DEGREES CENTIGRADE

|     | S     | T     | R     | M     | D     | K     | G     | J     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| WDS | -27.0 | -27.0 | -27.0 | -26.9 | -26.9 | -26.9 | -26.9 | -26.9 |
| WDU | -26.8 | -26.8 | -26.8 | -26.8 | -26.7 | -26.7 | -26.7 | -26.7 |
| WDR | -26.7 | -26.6 | -26.6 | -26.6 | -26.6 | -26.5 | -26.5 | -26.5 |
| WDM | -26.5 | -26.4 | -26.4 | -26.4 | -26.4 | -26.3 | -26.3 | -26.3 |
| WDD | -26.3 | -26.3 | -26.3 | -26.2 | -26.2 | -26.2 | -26.2 | -26.2 |
| WDK | -26.1 | -26.1 | -26.1 | -26.1 | -26.1 | -26.1 | -26.1 | -26.1 |
| WDG | -25.9 | -25.9 | -25.9 | -25.9 | -25.9 | -25.9 | -25.9 | -25.9 |
| WDO | -25.8 | -25.7 | -25.7 | -25.7 | -25.7 | -25.6 | -25.6 | -25.6 |
| WKS | -25.6 | -25.6 | -25.6 | -25.5 | -25.5 | -25.5 | -25.5 | -25.5 |
| WKU | -25.4 | -25.4 | -25.4 | -25.4 | -25.3 | -25.3 | -25.3 | -25.3 |
| WKR | -25.3 | -25.2 | -25.2 | -25.2 | -25.2 | -25.1 | -25.1 | -25.1 |
| WKD | -25.1 | -25.1 | -25.1 | -25.0 | -25.0 | -25.0 | -25.0 | -25.0 |
| WKK | -24.9 | -24.9 | -24.9 | -24.9 | -24.9 | -24.8 | -24.8 | -24.8 |
| WKG | -24.7 | -24.7 | -24.7 | -24.7 | -24.6 | -24.6 | -24.6 | -24.6 |
| WKO | -24.5 | -24.5 | -24.5 | -24.5 | -24.5 | -24.4 | -24.4 | -24.4 |
| WGS | -24.2 | -24.2 | -24.1 | -24.1 | -24.1 | -24.1 | -24.1 | -24.1 |
| WGU | -24.0 | -24.0 | -24.0 | -24.0 | -24.0 | -23.9 | -23.9 | -23.9 |
| WGR | -23.8 | -23.8 | -23.8 | -23.8 | -23.7 | -23.7 | -23.7 | -23.7 |
| WGM | -23.7 | -23.6 | -23.6 | -23.6 | -23.6 | -23.5 | -23.5 | -23.5 |
| WGD | -23.5 | -23.5 | -23.4 | -23.4 | -23.4 | -23.4 | -23.4 | -23.4 |
| WCK | -23.3 | -23.3 | -23.3 | -23.2 | -23.2 | -23.2 | -23.2 | -23.2 |
| WGG | -23.1 | -23.1 | -23.1 | -23.1 | -23.0 | -23.0 | -23.0 | -23.0 |
| WGO | -23.0 | -22.9 | -22.9 | -22.9 | -22.9 | -22.8 | -22.8 | -22.8 |
| WOS | -22.8 | -22.8 | -22.7 | -22.7 | -22.7 | -22.7 | -22.6 | -22.6 |
| WOU | -22.6 | -22.6 | -22.6 | -22.5 | -22.5 | -22.5 | -22.5 | -22.5 |
| WOR | -22.4 | -22.4 | -22.4 | -22.4 | -22.3 | -22.3 | -22.3 | -22.3 |
| WOM | -22.2 | -22.2 | -22.2 | -22.2 | -22.2 | -22.1 | -22.1 | -22.1 |
| WOD | -22.1 | -22.0 | -22.0 | -22.0 | -22.0 | -21.9 | -21.9 | -21.9 |
| WOK | -21.9 | -21.9 | -21.8 | -21.8 | -21.8 | -21.8 | -21.8 | -21.8 |
| WOG | -21.7 | -21.7 | -21.7 | -21.6 | -21.6 | -21.6 | -21.6 | -21.6 |
| WOO | -21.5 | -21.5 | -21.5 | -21.5 | -21.4 | -21.4 | -21.4 | -21.4 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

— THERMISTOR CALIBRATION RESULTS S/N U083131 DATE 27 MAR 75 PAGE 8

TEMPERATURE IN DEGREES CENTIGRADE

|     | S     | U     | R     | W     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| DSS | -21.3 | -21.3 | -21.3 | -21.3 | -21.3 | -21.2 | -21.2 | -21.2 |
| DSU | -21.2 | -21.1 | -21.1 | -21.1 | -21.1 | -21.1 | -21.1 | -21.1 |
| DSR | -21.8 | -21.8 | -21.8 | -21.8 | -21.8 | -21.8 | -21.8 | -21.8 |
| DSN | -20.8 | -20.8 | -20.8 | -20.8 | -20.8 | -20.7 | -20.7 | -20.7 |
| DSO | -20.6 | -20.6 | -20.6 | -20.6 | -20.6 | -20.5 | -20.5 | -20.5 |
| DSK | -20.5 | -20.4 | -20.4 | -20.4 | -20.4 | -20.3 | -20.3 | -20.3 |
| DSG | -20.3 | -20.2 | -20.2 | -20.2 | -20.2 | -20.1 | -20.1 | -20.1 |
| DSO | -20.1 | -20.1 | -20.1 | -20.1 | -20.1 | -20.0 | -20.0 | -20.0 |
| DUS | -19.9 | -19.9 | -19.9 | -19.9 | -19.8 | -19.8 | -19.8 | -19.8 |
| DUU | -19.7 | -19.7 | -19.7 | -19.7 | -19.6 | -19.6 | -19.6 | -19.6 |
| DUR | -19.5 | -19.5 | -19.5 | -19.5 | -19.5 | -19.4 | -19.4 | -19.4 |
| DUN | -19.4 | -19.3 | -19.3 | -19.3 | -19.3 | -19.2 | -19.2 | -19.2 |
| DUD | -19.2 | -19.2 | -19.2 | -19.2 | -19.1 | -19.1 | -19.1 | -19.1 |
| DUK | -19.0 | -19.0 | -19.0 | -19.0 | -18.9 | -18.9 | -18.9 | -18.9 |
| DUG | -18.8 | -18.8 | -18.8 | -18.8 | -18.7 | -18.7 | -18.7 | -18.7 |
| DUO | -18.6 | -18.6 | -18.6 | -18.6 | -18.5 | -18.5 | -18.5 | -18.5 |
| DMS | -18.4 | -18.4 | -18.4 | -18.4 | -18.3 | -18.3 | -18.3 | -18.3 |
| DMU | -18.3 | -18.2 | -18.2 | -18.2 | -18.2 | -18.1 | -18.1 | -18.1 |
| DMR | -18.1 | -18.1 | -18.1 | -18.1 | -18.0 | -18.0 | -18.0 | -18.0 |
| DMN | -17.9 | -17.9 | -17.9 | -17.9 | -17.8 | -17.8 | -17.8 | -17.8 |
| DMO | -17.7 | -17.7 | -17.7 | -17.7 | -17.6 | -17.6 | -17.6 | -17.6 |
| DMK | -17.5 | -17.5 | -17.5 | -17.5 | -17.5 | -17.4 | -17.4 | -17.4 |
| DMG | -17.3 | -17.3 | -17.3 | -17.3 | -17.2 | -17.2 | -17.2 | -17.2 |
| DMO | -17.1 | -17.1 | -17.1 | -17.1 | -17.1 | -17.0 | -17.0 | -17.0 |
| DMS | -16.9 | -16.9 | -16.9 | -16.9 | -16.9 | -16.8 | -16.8 | -16.8 |
| DMU | -16.8 | -16.8 | -16.8 | -16.8 | -16.7 | -16.7 | -16.7 | -16.7 |
| DMR | -16.6 | -16.6 | -16.6 | -16.6 | -16.5 | -16.5 | -16.5 | -16.5 |
| DMN | -16.4 | -16.4 | -16.4 | -16.4 | -16.3 | -16.3 | -16.3 | -16.3 |
| DMO | -16.2 | -16.2 | -16.2 | -16.2 | -16.1 | -16.1 | -16.1 | -16.1 |
| DMK | -16.0 | -16.0 | -16.0 | -16.0 | -15.9 | -15.9 | -15.9 | -15.9 |
| DMG | -15.8 | -15.8 | -15.8 | -15.8 | -15.7 | -15.7 | -15.7 | -15.7 |
| DMO | -15.6 | -15.6 | -15.6 | -15.6 | -15.5 | -15.5 | -15.5 | -15.5 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

— THERMISTOR CALIBRATION RESULTS S/N U0621J1 DATE 27 MAR 76 PAGE 9

| TEMPERATURE IN DEGREES CENTIGRADE |       |       |       |       |       |       |       |       |       |       |
|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                                   | S     | U     | R     | W     | D     | K     | G     | U     |       |       |
| 00S                               | -15.5 | -15.4 | -15.4 | -15.4 | -15.4 | -15.3 | -15.3 | -15.3 | -15.3 | -15.3 |
| 00U                               | -15.3 | -15.2 | -15.2 | -15.2 | -15.2 | -15.1 | -15.1 | -15.1 | -15.1 | -15.1 |
| 00R                               | -15.1 | -15.0 | -15.0 | -15.0 | -15.0 | -14.9 | -14.9 | -14.9 | -14.9 | -14.9 |
| 00M                               | -14.9 | -14.9 | -14.8 | -14.8 | -14.8 | -14.7 | -14.7 | -14.7 | -14.7 | -14.7 |
| 00D                               | -14.7 | -14.7 | -14.6 | -14.6 | -14.6 | -14.5 | -14.5 | -14.5 | -14.5 | -14.5 |
| 00K                               | -14.5 | -14.5 | -14.4 | -14.4 | -14.4 | -14.3 | -14.3 | -14.3 | -14.3 | -14.3 |
| 006                               | -14.3 | -14.3 | -14.3 | -14.3 | -14.2 | -14.2 | -14.2 | -14.2 | -14.2 | -14.2 |
| 000                               | -14.1 | -14.1 | -14.1 | -14.1 | -14.1 | -14.0 | -14.0 | -14.0 | -14.0 | -14.0 |
| 00S                               | -13.9 | -13.9 | -13.9 | -13.8 | -13.8 | -13.8 | -13.8 | -13.8 | -13.8 | -13.8 |
| 00U                               | -13.7 | -13.7 | -13.7 | -13.6 | -13.6 | -13.6 | -13.6 | -13.6 | -13.6 | -13.6 |
| 00R                               | -13.5 | -13.5 | -13.5 | -13.5 | -13.4 | -13.4 | -13.4 | -13.4 | -13.4 | -13.4 |
| 00M                               | -13.3 | -13.3 | -13.3 | -13.3 | -13.2 | -13.2 | -13.2 | -13.2 | -13.2 | -13.2 |
| 00D                               | -13.1 | -13.1 | -13.1 | -13.1 | -13.0 | -13.0 | -13.0 | -13.0 | -13.0 | -13.0 |
| 00K                               | -12.9 | -12.9 | -12.9 | -12.9 | -12.8 | -12.8 | -12.8 | -12.8 | -12.8 | -12.8 |
| 006                               | -12.7 | -12.7 | -12.7 | -12.7 | -12.6 | -12.6 | -12.6 | -12.6 | -12.6 | -12.6 |
| 000                               | -12.5 | -12.5 | -12.5 | -12.5 | -12.4 | -12.4 | -12.4 | -12.4 | -12.4 | -12.4 |
| 00S                               | -12.3 | -12.3 | -12.3 | -12.3 | -12.2 | -12.2 | -12.2 | -12.2 | -12.2 | -12.2 |
| 00U                               | -12.1 | -12.1 | -12.1 | -12.1 | -12.0 | -12.0 | -12.0 | -12.0 | -12.0 | -12.0 |
| 00R                               | -11.9 | -11.9 | -11.9 | -11.9 | -11.8 | -11.8 | -11.8 | -11.8 | -11.8 | -11.8 |
| 00M                               | -11.7 | -11.7 | -11.7 | -11.7 | -11.6 | -11.6 | -11.6 | -11.6 | -11.6 | -11.6 |
| 00D                               | -11.5 | -11.5 | -11.5 | -11.5 | -11.4 | -11.4 | -11.4 | -11.4 | -11.4 | -11.4 |
| 00K                               | -11.3 | -11.3 | -11.3 | -11.3 | -11.2 | -11.2 | -11.2 | -11.2 | -11.2 | -11.2 |
| 006                               | -11.1 | -11.1 | -11.1 | -11.1 | -11.0 | -11.0 | -11.0 | -11.0 | -11.0 | -11.0 |
| 000                               | -10.9 | -10.9 | -10.9 | -10.9 | -10.8 | -10.8 | -10.8 | -10.8 | -10.8 | -10.8 |
| 00S                               | -10.7 | -10.7 | -10.7 | -10.7 | -10.6 | -10.6 | -10.6 | -10.6 | -10.6 | -10.6 |
| 00U                               | -10.5 | -10.5 | -10.5 | -10.5 | -10.4 | -10.4 | -10.4 | -10.4 | -10.4 | -10.4 |
| 00R                               | -10.3 | -10.3 | -10.3 | -10.3 | -10.2 | -10.2 | -10.2 | -10.2 | -10.2 | -10.2 |
| 00M                               | -10.1 | -10.1 | -10.1 | -10.1 | -10.0 | -10.0 | -10.0 | -10.0 | -10.0 | -10.0 |
| 00D                               | -9.9  | -9.9  | -9.9  | -9.9  | -9.8  | -9.8  | -9.8  | -9.8  | -9.8  | -9.8  |
| 00K                               | -9.7  | -9.7  | -9.7  | -9.7  | -9.6  | -9.6  | -9.6  | -9.6  | -9.6  | -9.6  |
| 006                               | -9.5  | -9.5  | -9.5  | -9.5  | -9.4  | -9.4  | -9.4  | -9.4  | -9.4  | -9.4  |
| 000                               | -9.3  | -9.3  | -9.3  | -9.3  | -9.2  | -9.2  | -9.2  | -9.2  | -9.2  | -9.2  |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

THEMISTOR CALIBRATION RESULTS S/N U081J1 DATE 27 MAR 76 PAGE 1

TEMPERATURE IN DEGREES CENTIGRADE

|     | S    | T    | R    | M    | D    | K    | G    | O    |
|-----|------|------|------|------|------|------|------|------|
| KSS | -9.1 | -9.1 | -9.1 | -9.0 | -9.9 | -9.0 | -9.3 | -8.9 |
| KSU | -8.9 | -8.9 | -8.9 | -8.8 | -8.8 | -8.8 | -8.3 | -8.7 |
| KSK | -8.7 | -8.7 | -8.6 | -8.6 | -8.6 | -8.5 | -8.5 | -8.5 |
| KSM | -8.5 | -8.5 | -8.4 | -8.4 | -8.4 | -8.4 | -8.3 | -8.3 |
| KSD | -8.3 | -8.3 | -8.2 | -8.2 | -8.2 | -8.2 | -8.1 | -8.1 |
| KSK | -8.1 | -8.1 | -8.0 | -8.0 | -8.0 | -7.9 | -7.9 | -7.9 |
| KSG | -7.9 | -7.8 | -7.8 | -7.8 | -7.8 | -7.7 | -7.7 | -7.7 |
| KSO | -7.7 | -7.6 | -7.6 | -7.6 | -7.6 | -7.5 | -7.5 | -7.5 |
| KUS | -7.4 | -7.4 | -7.4 | -7.4 | -7.3 | -7.3 | -7.3 | -7.3 |
| KUR | -7.2 | -7.2 | -7.0 | -6.9 | -6.9 | -6.9 | -6.9 | -6.9 |
| KUM | -6.8 | -6.8 | -6.8 | -6.7 | -6.7 | -6.7 | -6.7 | -6.7 |
| KUD | -6.6 | -6.6 | -6.5 | -6.5 | -6.5 | -6.5 | -6.4 | -6.4 |
| KUK | -6.4 | -6.4 | -6.3 | -6.3 | -6.3 | -6.2 | -6.2 | -6.2 |
| KUG | -6.2 | -6.1 | -6.1 | -6.1 | -6.1 | -6.1 | -6.1 | -6.1 |
| KUO | -6.0 | -5.9 | -5.9 | -5.9 | -5.8 | -5.8 | -5.9 | -5.8 |
| KRS | -5.7 | -5.7 | -5.7 | -5.7 | -5.6 | -5.6 | -5.5 | -5.5 |
| KRU | -5.5 | -5.5 | -5.5 | -5.4 | -5.4 | -5.4 | -5.4 | -5.4 |
| KRR | -5.3 | -5.3 | -5.2 | -5.2 | -5.2 | -5.2 | -5.1 | -5.1 |
| KRM | -5.1 | -5.0 | -5.0 | -5.0 | -5.0 | -4.9 | -4.9 | -4.9 |
| KRD | -4.9 | -4.8 | -4.8 | -4.8 | -4.7 | -4.7 | -4.7 | -4.7 |
| KRK | -4.6 | -4.6 | -4.6 | -4.5 | -4.5 | -4.5 | -4.5 | -4.5 |
| KRG | -4.4 | -4.4 | -4.4 | -4.3 | -4.3 | -4.3 | -4.2 | -4.2 |
| KRO | -4.2 | -4.2 | -4.1 | -4.1 | -4.1 | -4.1 | -4.1 | -4.1 |
| KNS | -4.0 | -3.9 | -3.9 | -3.9 | -3.8 | -3.8 | -3.8 | -3.8 |
| KNU | -3.7 | -3.7 | -3.7 | -3.6 | -3.6 | -3.6 | -3.6 | -3.6 |
| KNR | -3.5 | -3.5 | -3.4 | -3.4 | -3.4 | -3.4 | -3.3 | -3.3 |
| KNW | -3.3 | -3.2 | -3.2 | -3.2 | -3.1 | -3.1 | -3.1 | -3.1 |
| KND | -3.0 | -3.0 | -3.0 | -3.0 | -2.9 | -2.9 | -2.9 | -2.9 |
| KNK | -2.8 | -2.8 | -2.8 | -2.7 | -2.7 | -2.7 | -2.6 | -2.6 |
| KNG | -2.6 | -2.5 | -2.5 | -2.5 | -2.5 | -2.4 | -2.4 | -2.4 |
| KNO | -2.3 | -2.3 | -2.3 | -2.3 | -2.2 | -2.2 | -2.2 | -2.1 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

THEMISTOR CALIBRATION RESULTS S/N U881J1 DATE 27 MAR 76 PAGE 11

TEMPERATURE IN DEGREES CENTIGRADE

|     | S    | M    | R    | W    | D    | K    | G    | O    |
|-----|------|------|------|------|------|------|------|------|
| KDS | -2.1 | -2.1 | -2.1 | -2.0 | -2.1 | -2.1 | -1.9 | -1.9 |
| KDU | -1.9 | -1.8 | -1.8 | -1.8 | -1.8 | -1.7 | -1.7 | -1.7 |
| KDM | -1.6 | -1.6 | -1.6 | -1.5 | -1.5 | -1.5 | -1.5 | -1.4 |
| KDN | -1.4 | -1.4 | -1.3 | -1.3 | -1.3 | -1.3 | -1.2 | -1.2 |
| KDO | -1.2 | -1.1 | -1.1 | -1.1 | -1.1 | -1.0 | -1.0 | -1.0 |
| KDK | -0.9 | -0.9 | -0.9 | -0.8 | -0.8 | -0.8 | -0.7 | -0.7 |
| KDG | -0.7 | -0.6 | -0.6 | -0.6 | -0.6 | -0.5 | -0.5 | -0.5 |
| KDO | -0.4 | -0.4 | -0.4 | -0.3 | -0.3 | -0.3 | -0.2 | -0.2 |
| KKS | -0.2 | -0.2 | -0.1 | -0.1 | -0.1 | -0.2 | -0.2 | -0.3 |
| KKU | 0.1  | 0.1  | 0.1  | 0.1  | 0.2  | 0.2  | 0.2  | 0.3  |
| KKR | 0.3  | 0.3  | 0.4  | 0.4  | 0.5  | 0.5  | 0.5  | 0.6  |
| KKM | 0.5  | 0.6  | 0.6  | 0.6  | 0.7  | 0.7  | 0.7  | 0.8  |
| KKN | 0.8  | 0.8  | 0.9  | 0.9  | 0.9  | 0.9  | 1.0  | 1.0  |
| KKO | 1.0  | 1.1  | 1.1  | 1.1  | 1.2  | 1.2  | 1.2  | 1.2  |
| KKG | 1.3  | 1.3  | 1.3  | 1.4  | 1.4  | 1.4  | 1.4  | 1.5  |
| KKO | 1.5  | 1.6  | 1.6  | 1.6  | 1.6  | 1.7  | 1.7  | 1.7  |
| KGS | 1.8  | 1.8  | 1.8  | 1.9  | 1.9  | 1.9  | 2.0  | 2.0  |
| KGU | 2.0  | 2.1  | 2.1  | 2.1  | 2.2  | 2.2  | 2.2  | 2.2  |
| KGR | 2.3  | 2.3  | 2.3  | 2.4  | 2.4  | 2.4  | 2.4  | 2.5  |
| KGM | 2.5  | 2.6  | 2.6  | 2.6  | 2.7  | 2.7  | 2.7  | 2.8  |
| KGO | 2.8  | 2.9  | 2.9  | 2.9  | 2.9  | 2.9  | 3.0  | 3.0  |
| KGX | 3.1  | 3.1  | 3.1  | 3.1  | 3.2  | 3.2  | 3.2  | 3.3  |
| KGG | 3.3  | 3.3  | 3.4  | 3.4  | 3.4  | 3.5  | 3.5  | 3.5  |
| KGO | 3.6  | 3.6  | 3.6  | 3.7  | 3.7  | 3.7  | 3.8  | 3.8  |
| KDS | 3.8  | 3.9  | 3.9  | 3.9  | 4.0  | 4.0  | 4.0  | 4.1  |
| KDU | 4.1  | 4.1  | 4.2  | 4.2  | 4.2  | 4.3  | 4.3  | 4.3  |
| KDR | 4.4  | 4.4  | 4.4  | 4.5  | 4.5  | 4.5  | 4.6  | 4.6  |
| KDM | 4.6  | 4.7  | 4.7  | 4.8  | 4.8  | 4.9  | 4.9  | 4.9  |
| KDN | 4.9  | 5.0  | 5.0  | 5.0  | 5.1  | 5.1  | 5.1  | 5.2  |
| KDO | 5.2  | 5.2  | 5.3  | 5.3  | 5.3  | 5.4  | 5.4  | 5.4  |
| KDK | 5.5  | 5.5  | 5.5  | 5.6  | 5.6  | 5.7  | 5.7  | 5.7  |
| KDG | 5.8  | 5.8  | 5.8  | 5.9  | 5.9  | 5.9  | 6.0  | 6.0  |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

--- THERMISTOR CALIBRATION RESULTS S/N U0831J1 DATE 27 MAR 76 PAGE 12

TEMPERATURE IN DEGREES CENTIGRADE

|     | S    | U    | R    | M    | O    | K    | G    | U    |
|-----|------|------|------|------|------|------|------|------|
| 6SS | 6.0  | 6.1  | 6.1  | 6.1  | 6.2  | 6.2  | 6.3  | 6.3  |
| GSU | 6.3  | 6.4  | 6.4  | 6.4  | 6.5  | 6.5  | 6.5  | 6.5  |
| 6SR | 6.6  | 6.6  | 6.7  | 6.7  | 6.8  | 6.8  | 6.8  | 6.9  |
| GSW | 6.9  | 6.9  | 7.0  | 7.0  | 7.1  | 7.1  | 7.1  | 7.2  |
| 6SD | 7.2  | 7.2  | 7.3  | 7.3  | 7.3  | 7.4  | 7.4  | 7.5  |
| GSX | 7.5  | 7.5  | 7.6  | 7.6  | 7.6  | 7.7  | 7.7  | 7.8  |
| 6SG | 7.8  | 7.8  | 7.9  | 7.9  | 7.9  | 8.0  | 8.1  | 8.1  |
| 6SO | 8.1  | 8.1  | 8.2  | 8.2  | 8.2  | 8.3  | 8.3  | 8.4  |
| GUS | 8.4  | 8.4  | 8.5  | 8.5  | 8.6  | 8.6  | 8.6  | 8.7  |
| 6UU | 8.7  | 8.7  | 8.8  | 8.8  | 8.9  | 8.9  | 8.9  | 9.0  |
| GUP | 9.0  | 9.1  | 9.1  | 9.1  | 9.2  | 9.2  | 9.2  | 9.3  |
| GUM | 9.3  | 9.4  | 9.4  | 9.4  | 9.5  | 9.5  | 9.6  | 9.6  |
| GUD | 9.6  | 9.7  | 9.7  | 9.8  | 9.8  | 9.8  | 9.8  | 9.9  |
| 6UX | 10.0 | 10.0 | 10.0 | 10.1 | 10.1 | 10.2 | 10.2 | 10.2 |
| GUG | 10.3 | 10.3 | 10.4 | 10.4 | 10.4 | 10.5 | 10.5 | 10.6 |
| 6UU | 10.6 | 10.6 | 10.7 | 10.7 | 10.8 | 10.8 | 10.9 | 10.9 |
| GRS | 10.9 | 11.0 | 11.0 | 11.1 | 11.1 | 11.1 | 11.2 | 11.2 |
| GRU | 11.3 | 11.3 | 11.3 | 11.4 | 11.4 | 11.5 | 11.5 | 11.5 |
| GRR | 11.6 | 11.6 | 11.7 | 11.7 | 11.8 | 11.8 | 11.9 | 11.9 |
| GRM | 11.9 | 12.0 | 12.0 | 12.1 | 12.1 | 12.1 | 12.2 | 12.2 |
| GRD | 12.3 | 12.3 | 12.4 | 12.4 | 12.4 | 12.5 | 12.5 | 12.6 |
| GRK | 12.6 | 12.7 | 12.7 | 12.7 | 12.8 | 12.8 | 12.9 | 12.9 |
| GRG | 13.0 | 13.0 | 13.1 | 13.1 | 13.1 | 13.2 | 13.2 | 13.3 |
| GRD | 13.3 | 13.4 | 13.4 | 13.5 | 13.5 | 13.5 | 13.6 | 13.6 |
| GNS | 13.7 | 13.7 | 13.8 | 13.8 | 13.9 | 13.9 | 13.9 | 14.0 |
| GNU | 14.0 | 14.1 | 14.1 | 14.2 | 14.2 | 14.3 | 14.3 | 14.3 |
| GNR | 14.4 | 14.4 | 14.5 | 14.5 | 14.6 | 14.6 | 14.7 | 14.7 |
| GNN | 14.8 | 14.8 | 14.9 | 14.9 | 15.0 | 15.0 | 15.1 | 15.1 |
| GND | 15.1 | 15.2 | 15.2 | 15.3 | 15.3 | 15.4 | 15.4 | 15.4 |
| GNG | 15.5 | 15.5 | 15.6 | 15.6 | 15.7 | 15.7 | 15.8 | 15.8 |
| GNG | 15.9 | 15.9 | 16.0 | 16.0 | 16.1 | 16.1 | 16.2 | 16.2 |
| GND | 16.3 | 16.3 | 16.3 | 16.4 | 16.4 | 16.5 | 16.5 | 16.5 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

--- THERMISTOR CALIBRATION RESULTS S/N UUB31J1 DATE 27 MAR 76 PAGE 13 ---

| TEMPERATURE IN DEGREES CENTIGRADE |      |      |      |      |      |      |      |      |  |  |
|-----------------------------------|------|------|------|------|------|------|------|------|--|--|
|                                   | S    | V    | R    | M    | D    | K    | G    | O    |  |  |
| GOS                               | 16.6 | 16.7 | 16.7 | 16.8 | 16.8 | 16.9 | 16.9 | 17.0 |  |  |
| GOU                               | 17.0 | 17.1 | 17.1 | 17.2 | 17.2 | 17.3 | 17.3 | 17.4 |  |  |
| GOW                               | 17.4 | 17.5 | 17.5 | 17.6 | 17.6 | 17.7 | 17.7 | 17.8 |  |  |
| GOW                               | 17.8 | 17.9 | 17.9 | 18.0 | 18.0 | 18.1 | 18.1 | 18.2 |  |  |
| GOW                               | 18.2 | 18.3 | 18.3 | 18.4 | 18.4 | 18.5 | 18.5 | 18.6 |  |  |
| GOK                               | 18.6 | 18.7 | 18.7 | 18.8 | 18.8 | 18.9 | 18.9 | 19.0 |  |  |
| GOS                               | 19.0 | 19.1 | 19.1 | 19.2 | 19.2 | 19.3 | 19.3 | 19.4 |  |  |
| GOU                               | 19.4 | 19.5 | 19.5 | 19.6 | 19.6 | 19.7 | 19.7 | 19.8 |  |  |
| GKS                               | 19.8 | 19.9 | 19.9 | 20.0 | 20.0 | 20.1 | 20.1 | 20.2 |  |  |
| GKU                               | 20.3 | 20.3 | 20.4 | 20.4 | 20.5 | 20.5 | 20.5 | 20.6 |  |  |
| GKR                               | 20.7 | 20.7 | 20.8 | 20.8 | 20.9 | 20.9 | 20.9 | 21.0 |  |  |
| GKW                               | 21.1 | 21.2 | 21.2 | 21.3 | 21.3 | 21.4 | 21.4 | 21.5 |  |  |
| GKO                               | 21.5 | 21.6 | 21.7 | 21.7 | 21.8 | 21.8 | 21.9 | 21.9 |  |  |
| GKK                               | 22.0 | 22.0 | 22.1 | 22.1 | 22.2 | 22.3 | 22.3 | 22.4 |  |  |
| GKG                               | 22.4 | 22.5 | 22.5 | 22.6 | 22.6 | 22.7 | 22.7 | 22.8 |  |  |
| GKO                               | 22.9 | 22.9 | 23.0 | 23.0 | 23.1 | 23.2 | 23.2 | 23.3 |  |  |
| GGS                               | 23.3 | 23.4 | 23.4 | 23.5 | 23.5 | 23.6 | 23.7 | 23.7 |  |  |
| GUU                               | 23.8 | 23.8 | 23.9 | 23.9 | 24.0 | 24.1 | 24.1 | 24.2 |  |  |
| GGR                               | 24.2 | 24.3 | 24.4 | 24.4 | 24.5 | 24.5 | 24.6 | 24.6 |  |  |
| GGW                               | 24.7 | 24.8 | 24.8 | 24.9 | 24.9 | 25.0 | 25.1 | 25.1 |  |  |
| GGU                               | 25.2 | 25.2 | 25.3 | 25.3 | 25.4 | 25.5 | 25.5 | 25.6 |  |  |
| GGK                               | 25.6 | 25.7 | 25.8 | 25.8 | 25.9 | 26.0 | 26.0 | 26.1 |  |  |
| GGS                               | 26.1 | 26.2 | 26.2 | 26.3 | 26.4 | 26.4 | 26.5 | 26.5 |  |  |
| GGO                               | 26.6 | 26.7 | 26.7 | 26.8 | 26.8 | 26.9 | 27.0 | 27.1 |  |  |
| GOS                               | 27.1 | 27.2 | 27.2 | 27.3 | 27.3 | 27.4 | 27.5 | 27.5 |  |  |
| GOU                               | 27.6 | 27.6 | 27.7 | 27.7 | 27.8 | 27.9 | 28.0 | 28.1 |  |  |
| GOR                               | 28.1 | 28.1 | 28.2 | 28.3 | 28.3 | 28.4 | 28.5 | 28.5 |  |  |
| GOW                               | 28.6 | 28.6 | 28.7 | 28.8 | 28.8 | 28.9 | 29.0 | 29.1 |  |  |
| GOU                               | 29.1 | 29.2 | 29.2 | 29.3 | 29.3 | 29.4 | 29.5 | 29.5 |  |  |
| GOK                               | 29.6 | 29.7 | 29.7 | 29.8 | 29.9 | 29.9 | 30.0 | 30.1 |  |  |
| GOS                               | 30.1 | 30.2 | 30.3 | 30.3 | 30.4 | 30.4 | 30.5 | 30.6 |  |  |
| GOU                               | 30.6 | 30.7 | 30.7 | 30.8 | 30.9 | 31.0 | 31.0 | 31.1 |  |  |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

| T     | GEUNFS | Ta    | T-Ta |
|-------|--------|-------|------|
| -68.0 | 297.0  | -68.0 | 0.0  |
| -68.0 | 447.0  | -68.0 | 0.0  |
| -68.0 | 509.0  | -68.0 | 0.0  |
| -68.0 | 462.0  | -68.0 | 0.0  |
| -48.0 | 1229.0 | -48.0 | 0.0  |
| -30.0 | 1657.0 | -30.0 | 0.0  |
| -28.0 | 2106.0 | -28.0 | 0.0  |
| -19.9 | 2525.0 | -19.9 | 0.0  |
| 0.0   | 2486.0 | 0.0   | 0.0  |
| 10.0  | 3177.0 | 10.0  | 0.0  |
| 20.0  | 3395.0 | 20.0  | 0.0  |

```

- 0044177 SCOPE 3.4.6 * CDC466A A.F.G.L.
00.36.34.COR020 FROM MFA
00.36.35.1P 00001400 WORDS - FILE INPUT , BC 60
00.36.35.COR001.1120.CM6000.
00.36.35. 2036 CORDELLA
00.36.36.FTN.SL.
00.36.44. .761 CP SECONDS COMPILE TIME
00.36.44.LOAD (INPUT)
00.36.44.10MP (160)
00.36.44.EXECUTE.
00.36.50. STOP
00.36.50. 1.271 CP SECONDS EXECUTION TIME
00.36.50.CP 0000550 WORDS - FILE OUTPUT , DC 40
00.36.51.WS 7160 WORDS ( 14336 MAX USED)
00.36.51.CPA 2.727 SEC. .055 COST
00.36.51.10 1.944 SEC. .012 COST
00.36.51.CM 75.535 KMS. .083 COST
00.36.51.SS COST OF JOB .151
00.36.51.PP 11.250 SEC. DATE 03/11/77
00.36.51.1J END OF JOB, **

***** CORD020 //// END OF LIST ////
***** CORD020 //// END OF LIST ////

```

## Appendix H

### Primary Altitude Program

#### H1. GENERAL

This program is keyed to a B-60 altitude sensor (Reference 9) when used through the SCADS-2 encoder. The end product is a dictionary converting an alpha-code to altitude in thousands of feet which is valid for at least 18 months if no changes are made in the B-60 sensor. A dictionary is needed for each sensor; changing encoders will not affect the validity of the program.

##### H1.1 The Algorithm

The physics of the sensor is such that the period of the output is directly proportional to pressure which decreases exponentially with altitude. Since the period is multiplied by a frequency in the encoder, the sensor-encoder interaction is defined by the equation

$$\text{count} = A e^{B \cdot \text{altitude}},$$

where count is the number of events registered in the encoder data counter; A and B are constants; and altitude is in feet. The signal processing is covered in detail in Reference 1 pages 468 and 469.

### H1.2 The Input

Each B-60 sensor is calibrated in a vacuum chamber for period (msec) vs altitude (thousands of ft). This data, the frequency with which the period will be multiplied, and the number of points over which the curve is to be fit are the required input. The period under discussion is that of the sensor core which is a blocking oscillator not that available at the output of the B-60 which is twice the basic period. A flip flop doubles the period to facilitate protecting the signal while moving it from the B-60 to the encoder. The base period is recovered by calibrating the B-60 in ascending and descending modes then dividing by four. The two multiplying frequencies are obtained from Reference 14.

### H1.3 The Output

This discussion is keyed to the computer printout which follows. After the cover sheet, program list, and memory map is the frequency, curve fitting interval, and number of data points. The next page starts the list of data as read from the cards. It is preceeded by the calculated code word. Sixteen pages of dictionary, suitable to be entered into a  $8 \times 10\frac{1}{2}$  in. ring binder follow the data. Note that the unneeded space at the right of each page has been utilized to display the calculated constants used to calculate that row of code. Cost and time data close the printout.

Since the program calculates an altitude for every code, the initial codes are filled with "altitudes" which are below sea level. These negative altitudes are ignored; the dictionary effectively begins at code SSKG for 590 feet.

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

[illegible]

174

```

PROGRAM 960      74/74      OPT=1

        J= IFIX(H(I)*.5)
        A= I(I)+2.0005
        WRITE(6,36) LETTR(J1),LETTR(J2),LETTR(J3),LETTR(J4),J,A
36  FORMAT(1H ,4A1,I0,F0.3)
39  I(I)= .3CLOCK(I)*CLOCK
        INT2= INT/2
        NCEND= IFIX(I*(INT2+.1))
        NC=0
        J= INT2+.1
        SH=0.0
        SH2= 0.0
        ST= 0.0
        SHT= 0.0
        AINT= FLOAT(INT)
        DO 50 I= 1,INT
        SH= SH+H(I)
        SH2= SH2+H(I)**2
        ST= ST+ALOG(I(I))
50  SHT= SH+H(I)*ALOG(I(I))
        B= (ST*SH-AINT*SH)/(SH*SH-AINT*SH2)
        A= (ST-B*SH)/AINT
        DO 50 J= 1,16
        WRITE(6,70) SN,DATE,J1
70  FORMAT(1H,6X,"B-66 CALIBRATION RESULTS",3X,"S/N ",2A,3X,"DATE ",
13A4," PAGE",I3,2X,"A",15X,"9")
        WRITE(6,71)
71  FORMAT(1H,6X,25X,"ALTITUDE IN THOUSANDS OF FEET")
        WRITE(6,75) LETTR
75  FORMAT(1H,6X,8(7X,A1))
        K1= (J1+.1)/2
        DO 100 J2= 1,4
        WRITE(6,76)
76  FORMAT(1H ,
        DO 300 J3= 1,8
        DO 200 J4= 1,8
        IF (NC.GT.NCEND) CALL AH(J)
        X(J4)=0.0
        GO TO 193
190  X(J4)= 0.0010*(ALOG(FLOAT(NC))-A)/3+.095
199  NC= NC+1
200  CONTINUE
        K2= MOD((J1-1)*.4+J2-1,8)+1
300  WRITE(6,301) LETTR(K1),LETTR(K2),LETTR(J3),X,A,3
301  FORMAT(1H ,6X,3A1,1X,F0.8,2,1X,2-15.8)
400  CONTINUE
500  CONTINUE
        N=N+1
        IF (N1.EQ.-1.0) GO TO 10
        STOP
        END

```

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PAGE 1

10. 9. 55

FIN 4. 5. 41

74.74 OPT=1

SUBROUTINE AB

```

1  SUBROUTINE AB(J)
   COMMON INT2,N,NC,NCEND,M12,1),T(C,1),A,D,SH,SH2,Sf,SH1,AINT
   IF(J*INT2.GT.N) RETURN
   K1=J-INT2
   K2= J*INT2
   J= J+1
   SH= SH-H(K1)*H(K2)
   SH2= SH2-H(K1)**2+H(K2)**2
   ST= ST-ALOG(T(K1))*ALOG(T(K2))
   SH1= SH1-H(K1)*ALOG(T(K1))+H(K2)*ALOG(T(K2))
   B=(ST*SH-AINT*SH1)/(SH*SH-AINT*SH2)
   A= (ST-B*SH)/AINT
   NCEND= IFIX(T(J))
   RETURN
   END
15

```

LOAD MAP - 964

FMA OF THE LOAD 111  
LMA-1 OF THE LOAD 20372

TRANSFER ADDRESS -- 96;

CYBER LOADER 1.1-460

4222

PROGRAM AND BLOCK ASSIGNMENTS.

| BLOCK | ADDRESS | LENGTH | FILE       | DATE     | PROCESSOR | VER | LEVEL | HARDWARE | COMMENTS                   |
|-------|---------|--------|------------|----------|-----------|-----|-------|----------|----------------------------|
| 960   | 111     | 4577   | LGO        | 05/11/77 | FTN       | 7.5 | 7.14  | UCB I    | FOR INITIALIZATION OF THE  |
| 961   | 4710    | 52     | LGO        | 05/11/77 | FTN       | 7.5 | 7.14  | UCB I    | COMMON DATA AND VARIABLES. |
| 962   | 4762    | 23     |            |          |           |     |       |          | INITIALIZE COMMON DATA.    |
| 963   | 5005    | 131    |            |          |           |     |       |          | COMMON DATA AND VARIABLES. |
| 964   | 5136    | 64     | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 965   | 5136    | 64     | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 966   | 5222    | 41     | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 967   | 5263    | 310    | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 968   | 5573    | 601    | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 969   | 6374    | 277    | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 970   | 6672    | 160    | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 971   | 7453    | 456    | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 972   | 7531    | 154    | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 973   | 7705    | 73     | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 974   | 10000   | 1      | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 975   | 10001   | 154    | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 976   | 10155   | 352    | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 977   | 10527   | 16     | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 978   | 10565   | 42     | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 979   | 14607   | 406    | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 980   | 11215   | 172    | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 981   | 11497   | 62     | SL-FORTRAN | 05/11/76 | COMPASS   | 3.  | 2-11  |          | COMMON DATA AND VARIABLES. |
| 982   | 11471   | 6      | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 983   | 11477   | 49     | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 984   | 11537   | 10     | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 985   | 11547   | 64     | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 986   | 11633   | 233    | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 987   | 12066   | 11     |            |          |           |     |       |          | COMMON DATA AND VARIABLES. |
| 988   | 12077   | 3      |            |          |           |     |       |          | COMMON DATA AND VARIABLES. |
| 989   | 12402   | 1      |            |          |           |     |       |          | COMMON DATA AND VARIABLES. |
| 990   | 12103   | 7      | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 991   | 12112   | 1      |            |          |           |     |       |          | COMMON DATA AND VARIABLES. |
| 992   | 12347   | 235    | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 993   | 12357   | 1      |            |          |           |     |       |          | COMMON DATA AND VARIABLES. |
| 994   | 12357   | 1362   | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 995   | 13741   | 260    | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 996   | 14221   | 7      | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 997   | 14230   | 23     | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 998   | 14253   | 5      |            |          |           |     |       |          | COMMON DATA AND VARIABLES. |
| 999   | 14260   | 144    | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 1000  | 14374   | 142    | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 1001  | 14536   | 47     | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 1002  | 14545   | 404    | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 1003  | 14614   | 7      | SL-SYSIO   | 05/26/76 | COMPASS   | 3.  | 75129 |          | COMMON DATA AND VARIABLES. |
| 1004  | 15220   |        |            |          |           |     |       |          | COMMON DATA AND VARIABLES. |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

2

445

0/11/77 0 000000

CYBER LOADER 1.1-42

LCAD MAP - R60

|           |       |      |            |                  |          |
|-----------|-------|------|------------|------------------|----------|
| CSUR.RM   | 15227 | 65   | SL-SYSIO   | 02/28/76 COMPASS | 1. 75128 |
| CPEW.SQ   | 15314 | 262  | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| CPEW.SQ   | 15576 | 14   | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| APUT.RT/  | 15612 | 11   | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| FLED.RM   | 15623 | 42   | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| CLSC.SQ   | 15665 | 132  | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| ACLSV.FO/ | 16017 | 7    | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| CLSV.SQ   | 16026 | 123  | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| AREW.FO/  | 16151 | 7    | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| REM.SQ    | 16160 | 31   | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| XGET.FO/  | 16211 | 7    | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| XGET.RT/  | 16220 | 11   | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| GET.SQ    | 16231 | 1035 | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| Z.SQ      | 17266 | 101  | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| FSUL.SQ   | 17367 | 156  | SL-SYSIO   | 02/28/76 COMPASS | 3. 75128 |
| SYS.RM    | 17475 | 37   | SL-NUCLEUS | 02/28/76 COMPASS | 3. 75128 |
| //        | 17534 | 636  |            |                  |          |

PROCESS SYSTEM 2.100.5.

12 1492 10V 5

321.09 CM STORAGE USED

514 CP SECONDS

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

CLOCK READ AS 6553.6  
INTERVAL READ AS 10  
N IS 136  
INTERVAL USED IS 10

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

|      |       |         |
|------|-------|---------|
| CODE | H(FT) | T(MSEC) |
| SSWG | 9     | 7.021   |
| SSWG | 1000  | 7.071   |
| SSWC | 2000  | 7.171   |
| SSCS | 3000  | 7.281   |
| SSCS | 4000  | 7.491   |
| SSGU | 5000  | 7.551   |
| SSGR | 6000  | 7.681   |
| SSGW | 7000  | 7.831   |
| SSGC | 8000  | 7.991   |
| SSCK | 9000  | 8.151   |
| SSGO | 10000 | 8.371   |
| SSOS | 11000 | 8.611   |
| SSOR | 12000 | 8.861   |
| SSOD | 13000 | 9.111   |
| SSOG | 14000 | 9.401   |
| SSOO | 15000 | 9.671   |
| SUSU | 16000 | 9.951   |
| SUSD | 17000 | 10.381  |
| SUSO | 18000 | 10.771  |
| SUNU | 19000 | 11.131  |
| SUUD | 20000 | 11.551  |
| SUOC | 21000 | 11.981  |
| SURR | 22000 | 12.481  |
| SURK | 23000 | 13.041  |
| SUNU | 24000 | 13.501  |
| SUNK | 25000 | 14.161  |
| SUCU | 26000 | 14.801  |
| SUDK | 27000 | 15.411  |
| SUKU | 28000 | 16.031  |
| SUKG | 29000 | 16.781  |
| SUGK | 30000 | 17.511  |
| SUGO | 31000 | 18.231  |
| SUOK | 32000 | 19.131  |
| SUSD | 33000 | 20.121  |
| SRUU | 34000 | 20.881  |
| SRUD | 35000 | 21.801  |
| SRPG | 36000 | 22.891  |
| SRWK | 37000 | 23.961  |
| SRDC | 38000 | 24.991  |
| SRKM | 39000 | 26.411  |
| SRGD | 40000 | 27.451  |
| SROR | 41000 | 28.451  |
| SRSK | 42000 | 30.021  |
| SRUG | 43000 | 31.361  |
| SRUP | 44000 | 33.201  |
| SRKU | 45000 | 35.561  |
| SRGD | 46000 | 37.241  |
| SDSS | 47000 | 39.891  |
| SDUD | 48000 | 40.921  |
| SDNU | 49000 | 42.921  |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

|      |       |         |
|------|-------|---------|
| CODE | HIFT) | T(MSEC) |
| SDDC | 50000 | 44.821  |
| SDEK | 51000 | 47.881  |
| SKSM | 52000 | 49.291  |
| SKRN | 53000 | 51.671  |
| SKOW | 54000 | 54.101  |
| SKGO | 55000 | 56.751  |
| SGSO | 56000 | 59.651  |
| SGMT | 57000 | 62.351  |
| SGKD | 58000 | 65.331  |
| SORS | 59000 | 68.431  |
| SORK | 60000 | 71.551  |
| SORC | 61000 | 75.031  |
| USSM | 62000 | 78.651  |
| USWD | 63000 | 82.381  |
| USGG | 64000 | 86.330  |
| UWPU | 65000 | 90.481  |
| UUKK | 66000 | 94.830  |
| URUN | 67000 | 99.359  |
| URKM | 68000 | 104.181 |
| UMNR | 69000 | 108.881 |
| UMKD | 70000 | 114.151 |
| UDOO | 71000 | 119.531 |
| UDGK | 72000 | 125.301 |
| UKMR | 73000 | 130.981 |
| UGSS | 74000 | 136.731 |
| UGRU | 75000 | 143.031 |
| UORD | 76000 | 149.601 |
| UQOS | 77000 | 156.801 |
| PSOU | 78000 | 164.901 |
| RUWK | 79000 | 170.431 |
| RRUG | 80000 | 177.931 |
| RMSR | 81000 | 185.781 |
| RMOR | 82000 | 194.331 |
| ROBR | 83000 | 202.881 |
| RKKW | 84000 | 211.601 |
| RGRU | 85000 | 221.051 |
| ROKU | 86000 | 230.881 |
| WSHA | 87000 | 240.931 |
| WUKO | 88000 | 251.381 |
| WRBO | 89000 | 262.681 |
| WDSD | 90000 | 274.081 |
| WKUG | 91000 | 285.281 |
| WGNP | 92000 | 296.881 |
| WGRG | 93000 | 309.981 |
| DUSK | 94000 | 323.031 |
| PRRS | 95000 | 334.481 |
| DNGW | 96000 | 349.551 |
| BKRD | 97000 | 364.451 |
| DGKD | 98000 | 377.751 |
| MSMN | 99000 | 394.681 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

| CODE | HIFT  | TIME     |
|------|-------|----------|
| KUOM | 10000 | 409.451  |
| KMKO | 10100 | 427.031  |
| KKPM | 10200 | 442.301  |
| KOUO | 10300 | 461.231  |
| GUSU | 10400 | 478.701  |
| GMSK | 10500 | 498.051  |
| GDCG | 10600 | 517.251  |
| 660W | 10700 | 536.001  |
| OUUM | 10800 | 555.251  |
| OMSO | 10900 | 577.251  |
| OKSR | 11000 | 596.001  |
| OMKG | 11100 | 622.251  |
| 5UCC | 11200 | 640.251  |
| 5MKU | 11300 | 660.501  |
| 5GDC | 11400 | 689.501  |
| 5SOD | 11500 | 712.251  |
| 5MSD | 11600 | 733.001  |
| 5KDG | 11700 | 757.751  |
| 5OKD | 11800 | 776.251  |
| 5MKD | 11900 | 807.501  |
| 5DCU | 12000 | 827.751  |
| 5OR6 | 12100 | 853.001  |
| 5UDM | 12200 | 874.501  |
| 50SS | 12300 | 898.500  |
| 5MPO | 12400 | 892.250  |
| 5RDR | 12500 | 962.250  |
| 5OKO | 12600 | 983.750  |
| 5RDO | 12700 | 982.500  |
| 5RDU | 12800 | 1040.251 |
| 5ORD | 12900 | 1057.751 |
| 5SUS | 13000 | 1095.001 |
| 5MRM | 13100 | 1126.001 |
| 5GOC | 13200 | 1162.001 |
| 5RRW | 13300 | 1194.251 |
| 5ORU | 13400 | 1213.501 |
| 5ORS | 13500 | 1242.751 |

B-68 CALIBRATION RESULTS S/N 020 DATE 21 OCT 75 PAGE 1

ALTITUDE IN THOUSANDS OF FEET

|     | S      | U       | P       | M       | D       | K       | G       | O       |
|-----|--------|---------|---------|---------|---------|---------|---------|---------|
| SSS | 0.00   | -223.39 | -182.84 | -159.12 | -140.29 | -129.24 | -118.57 | -107.22 |
| SSU | -10.74 | -94.85  | -88.69  | -83.11  | -78.02  | -73.34  | -69.07  | -65.12  |
| SSR | -64.19 | -57.54  | -54.30  | -51.14  | -48.14  | -45.28  | -42.55  | -40.03  |
| SSW | -37.47 | -35.08  | -32.79  | -30.58  | -28.45  | -26.41  | -24.52  | -22.77  |
| SSD | -20.64 | -18.64  | -17.09  | -15.40  | -13.75  | -12.15  | -10.61  | -9.12   |
| SSK | -7.59  | -6.14   | -4.73   | -3.30   | -2.01   | -0.72   | 0.53    | 1.82    |
| SSG | 3.08   | 4.29    | 5.44    | 6.55    | 7.54    | 8.42    | 9.20    | 9.87    |
| SSO | 10.51  | 11.21   | 11.85   | 12.45   | 13.02   | 13.56   | 14.07   | 14.54   |
| SUS | 15.09  | 15.56   | 16.04   | 16.48   | 16.92   | 17.33   | 17.70   | 18.04   |
| SUU | 18.53  | 18.92   | 19.29   | 19.64   | 19.99   | 20.33   | 20.66   | 20.98   |
| SUR | 21.30  | 21.61   | 21.93   | 22.24   | 22.57   | 22.83   | 23.14   | 23.42   |
| SUM | 23.76  | 23.98   | 24.25   | 24.51   | 24.77   | 25.04   | 25.29   | 25.55   |
| SUD | 25.79  | 26.04   | 26.29   | 26.53   | 26.77   | 26.99   | 27.23   | 27.45   |
| SUK | 27.68  | 27.91   | 28.12   | 28.33   | 28.55   | 28.76   | 28.99   | 29.19   |
| SUG | 29.40  | 29.60   | 29.81   | 30.01   | 30.21   | 30.41   | 30.61   | 30.81   |
| SUO | 30.99  | 31.18   | 31.37   | 31.55   | 31.74   | 31.92   | 32.10   | 32.28   |
| SMS | 32.46  | 32.63   | 32.81   | 32.98   | 33.15   | 33.32   | 33.49   | 33.66   |
| SPU | 33.82  | 33.98   | 34.14   | 34.30   | 34.46   | 34.61   | 34.77   | 34.93   |
| SPR | 35.09  | 35.24   | 35.39   | 35.54   | 35.69   | 35.84   | 35.99   | 36.15   |
| SPW | 36.29  | 36.44   | 36.59   | 36.73   | 36.87   | 37.02   | 37.15   | 37.29   |
| SPK | 37.53  | 37.67   | 37.71   | 37.85   | 38.00   | 38.13   | 38.27   | 38.41   |
| SPG | 38.53  | 38.66   | 38.79   | 38.92   | 39.05   | 39.18   | 39.24   | 39.31   |
| SPQ | 39.53  | 39.66   | 39.78   | 39.89   | 39.97   | 40.09   | 40.21   | 40.32   |
| SPO | 40.44  | 40.55   | 40.67   | 40.77   | 40.85   | 40.99   | 41.11   | 41.21   |
| SWS | 41.31  | 41.42   | 41.53   | 41.63   | 41.74   | 41.85   | 41.95   | 42.06   |
| SWU | 42.16  | 42.26   | 42.36   | 42.45   | 42.55   | 42.65   | 42.77   | 42.86   |
| SWR | 42.96  | 43.05   | 43.15   | 43.24   | 43.34   | 43.43   | 43.52   | 43.61   |
| SWW | 43.71  | 43.80   | 43.90   | 44.00   | 44.12   | 44.21   | 44.29   | 44.35   |
| SWD | 44.47  | 44.55   | 44.64   | 44.73   | 44.81   | 44.90   | 44.98   | 45.07   |
| SWK | 45.15  | 45.23   | 45.35   | 45.45   | 45.53   | 45.61   | 45.69   | 45.77   |
| SWG | 45.86  | 45.94   | 46.02   | 46.11   | 46.18   | 46.27   | 46.35   | 46.43   |
| SWO | 46.51  | 46.59   | 46.67   | 46.75   | 46.83   | 46.91   | 46.99   | 47.07   |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

8-68 CALIBRATION RESULTS S/M 029 DATE: 21 OCT 76 PAGE 2

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | R     | M     | D     | K     | G     |       |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| SOS | 47.14 | 47.23 | 47.31 | 47.39 | 47.47 | 47.54 | 47.62 | 47.7  |
| SOU | 47.78 | 47.85 | 47.93 | 48.00 | 48.18 | 48.13 | 48.21 | 48.29 |
| SOR | 48.36 | 48.44 | 48.52 | 48.59 | 48.67 | 48.75 | 48.82 | 48.9  |
| SOW | 49.37 | 49.84 | 49.09 | 49.15 | 49.2  | 49.31 | 49.39 | 49.46 |
| SOD | 49.54 | 49.61 | 49.69 | 49.75 | 49.84 | 49.91 | 49.98 | 50.0  |
| SOE | 50.12 | 50.20 | 50.27 | 50.34 | 50.41 | 50.48 | 50.56 | 50.63 |
| SOE | 50.79 | 50.77 | 50.84 | 50.91 | 50.98 | 51.04 | 51.11 | 51.18 |
| SOD | 51.24 | 51.31 | 51.38 | 51.45 | 51.52 | 51.59 | 51.66 | 51.72 |
| SKS | 51.79 | 51.85 | 51.92 | 51.99 | 52.05 | 52.12 | 52.19 | 52.25 |
| SKU | 52.32 | 52.38 | 52.45 | 52.51 | 52.57 | 52.64 | 52.71 | 52.77 |
| SKR | 52.83 | 52.89 | 52.96 | 53.02 | 53.13 | 53.15 | 53.21 | 53.27 |
| SKW | 53.33 | 53.40 | 53.46 | 53.52 | 53.58 | 53.64 | 53.71 | 53.76 |
| SKD | 53.82 | 53.88 | 53.94 | 54.01 | 54.07 | 54.13 | 54.19 | 54.25 |
| SKK | 54.31 | 54.37 | 54.43 | 54.49 | 54.55 | 54.61 | 54.66 | 54.72 |
| SKG | 54.78 | 54.83 | 54.89 | 54.95 | 55.01 | 55.07 | 55.12 | 55.18 |
| SKO | 55.24 | 55.29 | 55.35 | 55.41 | 55.46 | 55.52 | 55.58 | 55.63 |
| SGS | 55.69 | 55.74 | 55.80 | 55.85 | 55.91 | 55.96 | 56.02 | 56.08 |
| SGU | 56.13 | 56.19 | 56.24 | 56.29 | 56.35 | 56.41 | 56.46 | 56.51 |
| SGR | 56.56 | 56.62 | 56.67 | 56.72 | 56.78 | 56.83 | 56.88 | 56.94 |
| SGW | 56.99 | 57.04 | 57.09 | 57.14 | 57.21 | 57.25 | 57.31 | 57.36 |
| SGO | 57.40 | 57.45 | 57.51 | 57.56 | 57.61 | 57.66 | 57.71 | 57.76 |
| SGK | 57.81 | 57.86 | 57.91 | 57.96 | 58.01 | 58.06 | 58.11 | 58.16 |
| SGE | 58.21 | 58.26 | 58.31 | 58.36 | 58.41 | 58.45 | 58.51 | 58.56 |
| SGO | 58.61 | 58.65 | 58.71 | 58.75 | 58.81 | 58.85 | 58.91 | 58.95 |
| SOS | 59.09 | 59.14 | 59.19 | 59.23 | 59.28 | 59.33 | 59.37 | 59.42 |
| SOU | 59.37 | 59.42 | 59.46 | 59.51 | 59.56 | 59.61 | 59.65 | 59.7  |
| SOR | 59.74 | 59.79 | 59.84 | 59.89 | 59.93 | 59.97 | 60.01 | 60.06 |
| SOW | 60.11 | 60.15 | 60.2  | 60.24 | 60.29 | 60.33 | 60.38 | 60.42 |
| SOD | 60.47 | 60.51 | 60.56 | 60.60 | 60.65 | 60.69 | 60.74 | 60.78 |
| SOE | 60.83 | 60.87 | 60.91 | 60.96 | 61.01 | 61.05 | 61.1  | 61.13 |
| SOE | 61.18 | 61.22 | 61.26 | 61.31 | 61.35 | 61.39 | 61.44 | 61.48 |
| SOD | 61.52 | 61.56 | 61.61 | 61.65 | 61.69 | 61.73 | 61.78 | 61.82 |

185

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDG

| E-60 CALIBRATION RESULTS S/N 020 DATE: 21 OCT 76 PAGE: 6 |       |       |       |       |       |       |       |       |      |      |
|----------------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|
| ALTITUDE IN THOUSANDS OF FEET                            |       |       |       |       |       |       |       |       |      |      |
|                                                          | S     | U     | P     | M     | Q     | K     | G     | U     |      |      |
| UDS                                                      | 70.60 | 70.63 | 70.66 | 70.69 | 70.71 | 70.74 | 70.77 | 70.79 | 3.22 | 3.22 |
| UDU                                                      | 71.83 | 70.95 | 70.88 | 70.91 | 70.94 | 70.97 | 70.99 | 71.01 | 3.22 | 3.22 |
| UDR                                                      | 71.65 | 71.10 | 71.11 | 71.12 | 71.16 | 71.19 | 71.22 | 71.25 | 3.22 | 3.22 |
| UDM                                                      | 71.27 | 71.30 | 71.33 | 71.36 | 71.38 | 71.41 | 71.44 | 71.47 | 3.22 | 3.22 |
| UDC                                                      | 71.69 | 71.52 | 71.55 | 71.58 | 71.60 | 71.63 | 71.66 | 71.69 | 3.22 | 3.22 |
| UDK                                                      | 71.71 | 71.74 | 71.77 | 71.79 | 71.82 | 71.85 | 71.88 | 71.91 | 3.22 | 3.22 |
| UDG                                                      | 71.93 | 71.96 | 71.98 | 72.01 | 72.04 | 72.06 | 72.09 | 72.11 | 3.22 | 3.22 |
| UDQ                                                      | 72.15 | 72.18 | 72.20 | 72.23 | 72.26 | 72.29 | 72.31 | 72.34 | 3.22 | 3.22 |
| UKS                                                      | 72.36 | 72.39 | 72.42 | 72.44 | 72.47 | 72.50 | 72.52 | 72.54 | 3.22 | 3.22 |
| UKU                                                      | 72.56 | 72.60 | 72.63 | 72.65 | 72.68 | 72.71 | 72.73 | 72.75 | 3.22 | 3.22 |
| UKR                                                      | 72.79 | 72.81 | 72.84 | 72.86 | 72.89 | 72.92 | 72.94 | 72.97 | 3.22 | 3.22 |
| UKW                                                      | 72.99 | 73.02 | 73.05 | 73.06 | 73.09 | 73.11 | 73.13 | 73.15 | 3.22 | 3.22 |
| UKD                                                      | 73.18 | 73.21 | 73.23 | 73.26 | 73.29 | 73.31 | 73.34 | 73.36 | 3.22 | 3.22 |
| UKK                                                      | 73.39 | 73.41 | 73.44 | 73.46 | 73.49 | 73.51 | 73.54 | 73.56 | 3.22 | 3.22 |
| UKG                                                      | 73.59 | 73.61 | 73.64 | 73.66 | 73.69 | 73.71 | 73.74 | 73.76 | 3.22 | 3.22 |
| UKQ                                                      | 73.79 | 73.81 | 73.84 | 73.86 | 73.89 | 73.91 | 73.94 | 73.96 | 3.22 | 3.22 |
| UGS                                                      | 73.99 | 74.02 | 74.04 | 74.07 | 74.09 | 74.12 | 74.14 | 74.17 | 3.22 | 3.22 |
| UGU                                                      | 74.19 | 74.21 | 74.24 | 74.26 | 74.29 | 74.31 | 74.34 | 74.36 | 3.22 | 3.22 |
| UGR                                                      | 74.39 | 74.41 | 74.44 | 74.46 | 74.49 | 74.51 | 74.53 | 74.56 | 3.22 | 3.22 |
| UGW                                                      | 74.58 | 74.61 | 74.63 | 74.65 | 74.68 | 74.70 | 74.73 | 74.75 | 3.22 | 3.22 |
| UGD                                                      | 74.77 | 74.80 | 74.82 | 74.85 | 74.87 | 74.89 | 74.92 | 74.94 | 3.22 | 3.22 |
| UGK                                                      | 74.97 | 74.99 | 75.02 | 75.04 | 75.07 | 75.09 | 75.11 | 75.14 | 3.22 | 3.22 |
| UGG                                                      | 75.16 | 75.19 | 75.21 | 75.23 | 75.26 | 75.28 | 75.31 | 75.33 | 3.22 | 3.22 |
| UGQ                                                      | 75.35 | 75.38 | 75.40 | 75.42 | 75.45 | 75.47 | 75.49 | 75.52 | 3.22 | 3.22 |
| UOS                                                      | 75.54 | 75.56 | 75.59 | 75.61 | 75.63 | 75.66 | 75.68 | 75.71 | 3.22 | 3.22 |
| UOU                                                      | 75.73 | 75.75 | 75.77 | 75.80 | 75.82 | 75.84 | 75.87 | 75.89 | 3.22 | 3.22 |
| UOR                                                      | 75.91 | 75.94 | 75.96 | 75.99 | 76.01 | 76.03 | 76.05 | 76.07 | 3.22 | 3.22 |
| UOW                                                      | 76.10 | 76.12 | 76.15 | 76.17 | 76.19 | 76.22 | 76.24 | 76.26 | 3.22 | 3.22 |
| UOD                                                      | 76.28 | 76.31 | 76.33 | 76.35 | 76.38 | 76.40 | 76.42 | 76.44 | 3.22 | 3.22 |
| UOK                                                      | 76.47 | 76.49 | 76.51 | 76.53 | 76.56 | 76.58 | 76.60 | 76.62 | 3.22 | 3.22 |
| UOG                                                      | 76.65 | 76.67 | 76.69 | 76.72 | 76.74 | 76.76 | 76.78 | 76.80 | 3.22 | 3.22 |
| UOO                                                      | 76.83 | 76.85 | 76.87 | 76.89 | 76.92 | 76.94 | 76.96 | 76.98 | 3.22 | 3.22 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

| B-60 CALIBRATION RESULTS S/N 020 DATE 21 OCT 76 PAGE 5 |       |       |       |       |       |       |       |  |  |
|--------------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|--|--|
| ALTITUDE IN THOUSANDS OF FEET                          |       |       |       |       |       |       |       |  |  |
| S                                                      | U     | C     | M     | O     | K     | G     | U     |  |  |
| RSS                                                    | 77.01 | 77.03 | 77.05 | 77.07 | 77.13 | 77.12 | 77.14 |  |  |
| RSU                                                    | 77.18 | 77.21 | 77.23 | 77.25 | 77.27 | 77.29 | 77.31 |  |  |
| RSV                                                    | 77.36 | 77.38 | 77.40 | 77.42 | 77.44 | 77.46 | 77.48 |  |  |
| RSW                                                    | 77.53 | 77.56 | 77.58 | 77.60 | 77.62 | 77.64 | 77.66 |  |  |
| RSD                                                    | 77.71 | 77.73 | 77.75 | 77.77 | 77.79 | 77.81 | 77.83 |  |  |
| RSK                                                    | 77.88 | 77.90 | 77.92 | 77.94 | 77.96 | 77.98 | 78.00 |  |  |
| RSC                                                    | 78.05 | 78.07 | 78.09 | 78.11 | 78.13 | 78.15 | 78.17 |  |  |
| RSO                                                    | 78.22 | 78.24 | 78.26 | 78.28 | 78.30 | 78.32 | 78.34 |  |  |
| RUS                                                    | 78.39 | 78.41 | 78.43 | 78.45 | 78.47 | 78.49 | 78.51 |  |  |
| RUU                                                    | 78.56 | 78.58 | 78.60 | 78.62 | 78.64 | 78.66 | 78.68 |  |  |
| RUR                                                    | 78.73 | 78.75 | 78.77 | 78.79 | 78.81 | 78.83 | 78.85 |  |  |
| RUV                                                    | 78.89 | 78.91 | 78.93 | 78.95 | 78.97 | 78.99 | 79.01 |  |  |
| RWD                                                    | 79.05 | 79.07 | 79.09 | 79.11 | 79.13 | 79.15 | 79.17 |  |  |
| RUD                                                    | 79.22 | 79.24 | 79.26 | 79.28 | 79.30 | 79.32 | 79.34 |  |  |
| RUK                                                    | 79.38 | 79.40 | 79.42 | 79.44 | 79.46 | 79.48 | 79.50 |  |  |
| RUG                                                    | 79.54 | 79.56 | 79.58 | 79.60 | 79.62 | 79.64 | 79.66 |  |  |
| RUS                                                    | 79.70 | 79.72 | 79.74 | 79.76 | 79.78 | 79.80 | 79.82 |  |  |
| RUU                                                    | 79.86 | 79.88 | 79.90 | 79.92 | 79.94 | 79.96 | 79.98 |  |  |
| RUR                                                    | 80.01 | 80.03 | 80.05 | 80.07 | 80.09 | 80.11 | 80.13 |  |  |
| RUW                                                    | 80.17 | 80.19 | 80.21 | 80.23 | 80.25 | 80.27 | 80.29 |  |  |
| RSD                                                    | 80.33 | 80.35 | 80.37 | 80.39 | 80.41 | 80.43 | 80.45 |  |  |
| RSK                                                    | 80.48 | 80.50 | 80.52 | 80.54 | 80.56 | 80.58 | 80.60 |  |  |
| RSC                                                    | 80.64 | 80.66 | 80.68 | 80.70 | 80.72 | 80.74 | 80.76 |  |  |
| RSO                                                    | 80.79 | 80.81 | 80.83 | 80.85 | 80.87 | 80.89 | 80.91 |  |  |
| RUS                                                    | 80.95 | 80.97 | 80.99 | 81.01 | 81.03 | 81.05 | 81.07 |  |  |
| RUU                                                    | 81.09 | 81.11 | 81.13 | 81.15 | 81.17 | 81.19 | 81.21 |  |  |
| RUR                                                    | 81.24 | 81.26 | 81.28 | 81.30 | 81.32 | 81.34 | 81.36 |  |  |
| RUW                                                    | 81.39 | 81.41 | 81.43 | 81.45 | 81.47 | 81.49 | 81.51 |  |  |
| RSD                                                    | 81.54 | 81.56 | 81.58 | 81.60 | 81.62 | 81.64 | 81.66 |  |  |
| RSK                                                    | 81.69 | 81.71 | 81.73 | 81.75 | 81.77 | 81.79 | 81.81 |  |  |
| RSC                                                    | 81.84 | 81.86 | 81.88 | 81.89 | 81.91 | 81.93 | 81.95 |  |  |
| RSO                                                    | 81.99 | 82.00 | 82.01 | 82.03 | 82.05 | 82.06 | 82.08 |  |  |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

B-60 CALIBRATION RESULTS S/N 020 DATE 21 OCT 70 PAGE 6

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | P     | M     | N     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| RDS | 82.12 | 82.14 | 82.16 | 82.17 | 82.19 | 82.21 | 82.23 | 82.25 |
| RDU | 82.26 | 82.28 | 82.30 | 82.32 | 82.34 | 82.36 | 82.37 | 82.39 |
| RDR | 82.41 | 82.43 | 82.45 | 82.46 | 82.48 | 82.50 | 82.52 | 82.53 |
| RDM | 82.55 | 82.57 | 82.59 | 82.61 | 82.62 | 82.64 | 82.66 | 82.68 |
| RDD | 82.70 | 82.71 | 82.73 | 82.75 | 82.77 | 82.79 | 82.80 | 82.82 |
| RDK | 82.84 | 82.86 | 82.87 | 82.89 | 82.91 | 82.93 | 82.94 | 82.96 |
| RDE | 82.98 | 83.00 | 83.03 | 83.05 | 83.07 | 83.09 | 83.10 | 83.12 |
| RDF | 83.14 | 83.16 | 83.17 | 83.19 | 83.21 | 83.22 | 83.24 | 83.26 |
| RDS | 83.28 | 83.29 | 83.31 | 83.33 | 83.34 | 83.36 | 83.38 | 83.40 |
| RDU | 83.41 | 83.43 | 83.45 | 83.46 | 83.48 | 83.50 | 83.52 | 83.54 |
| RDR | 83.55 | 83.57 | 83.58 | 83.61 | 83.62 | 83.63 | 83.65 | 83.67 |
| RDM | 83.69 | 83.70 | 83.72 | 83.74 | 83.75 | 83.77 | 83.79 | 83.81 |
| RDD | 83.82 | 83.84 | 83.85 | 83.87 | 83.89 | 83.91 | 83.92 | 83.94 |
| RDK | 83.95 | 83.97 | 83.99 | 84.00 | 84.02 | 84.04 | 84.05 | 84.07 |
| RDE | 84.09 | 84.10 | 84.12 | 84.14 | 84.15 | 84.17 | 84.19 | 84.21 |
| RDF | 84.22 | 84.24 | 84.25 | 84.27 | 84.29 | 84.31 | 84.32 | 84.34 |
| RDS | 84.35 | 84.37 | 84.38 | 84.40 | 84.42 | 84.43 | 84.45 | 84.47 |
| RDU | 84.48 | 84.50 | 84.52 | 84.53 | 84.55 | 84.56 | 84.58 | 84.60 |
| RDR | 84.61 | 84.63 | 84.65 | 84.66 | 84.68 | 84.69 | 84.71 | 84.73 |
| RDM | 84.74 | 84.76 | 84.77 | 84.79 | 84.81 | 84.82 | 84.84 | 84.86 |
| RDD | 84.87 | 84.89 | 84.90 | 84.92 | 84.94 | 84.95 | 84.97 | 84.99 |
| RDK | 85.00 | 85.01 | 85.03 | 85.05 | 85.06 | 85.08 | 85.09 | 85.11 |
| RDE | 85.13 | 85.14 | 85.16 | 85.17 | 85.19 | 85.21 | 85.22 | 85.24 |
| RDF | 85.25 | 85.27 | 85.29 | 85.30 | 85.32 | 85.33 | 85.35 | 85.36 |
| RDS | 85.38 | 85.40 | 85.41 | 85.43 | 85.44 | 85.46 | 85.47 | 85.49 |
| RDU | 85.51 | 85.52 | 85.54 | 85.55 | 85.57 | 85.58 | 85.60 | 85.62 |
| RDR | 85.63 | 85.65 | 85.66 | 85.68 | 85.69 | 85.71 | 85.72 | 85.74 |
| RDM | 85.76 | 85.77 | 85.79 | 85.80 | 85.82 | 85.83 | 85.85 | 85.86 |
| RDD | 85.88 | 85.89 | 85.91 | 85.92 | 85.94 | 85.96 | 85.97 | 85.99 |
| RDK | 86.00 | 86.02 | 86.03 | 86.05 | 86.07 | 86.08 | 86.10 | 86.11 |
| RDE | 86.13 | 86.14 | 86.16 | 86.17 | 86.19 | 86.21 | 86.22 | 86.24 |
| RDF | 86.25 | 86.26 | 86.28 | 86.30 | 86.31 | 86.33 | 86.34 | 86.36 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

6-60 CALIBRATION RESULTS S/N 020 DATE: 21 OCT 76 PAGE 7

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | R     | M     | P     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| MSS | 86.37 | 86.39 | 86.42 | 86.43 | 86.45 | 86.45 | 86.45 | 86.45 |
| MSU | 86.49 | 86.51 | 86.52 | 86.53 | 86.54 | 86.55 | 86.55 | 86.55 |
| MSR | 86.61 | 86.63 | 86.64 | 86.65 | 86.66 | 86.67 | 86.67 | 86.67 |
| MSM | 86.73 | 86.75 | 86.76 | 86.77 | 86.78 | 86.79 | 86.79 | 86.79 |
| MSD | 86.85 | 86.87 | 86.88 | 86.89 | 86.90 | 86.91 | 86.91 | 86.91 |
| MSK | 86.97 | 86.99 | 87.00 | 87.01 | 87.02 | 87.03 | 87.03 | 87.03 |
| MSG | 87.10 | 87.11 | 87.12 | 87.13 | 87.14 | 87.15 | 87.15 | 87.15 |
| MSG | 87.22 | 87.23 | 87.24 | 87.25 | 87.26 | 87.27 | 87.27 | 87.27 |
| MUS | 87.33 | 87.35 | 87.36 | 87.37 | 87.38 | 87.39 | 87.39 | 87.39 |
| MUU | 87.45 | 87.47 | 87.48 | 87.49 | 87.50 | 87.51 | 87.51 | 87.51 |
| MUR | 87.57 | 87.58 | 87.59 | 87.60 | 87.61 | 87.62 | 87.62 | 87.62 |
| MUM | 87.66 | 87.67 | 87.68 | 87.69 | 87.70 | 87.71 | 87.71 | 87.71 |
| MUD | 87.80 | 87.81 | 87.82 | 87.83 | 87.84 | 87.85 | 87.85 | 87.85 |
| MUK | 87.91 | 87.92 | 87.93 | 87.94 | 87.95 | 87.96 | 87.96 | 87.96 |
| MUG | 88.03 | 88.05 | 88.06 | 88.07 | 88.08 | 88.09 | 88.09 | 88.09 |
| MUG | 88.15 | 88.16 | 88.17 | 88.18 | 88.19 | 88.20 | 88.20 | 88.20 |
| MRS | 88.26 | 88.27 | 88.28 | 88.29 | 88.30 | 88.31 | 88.31 | 88.31 |
| MRI | 88.37 | 88.39 | 88.40 | 88.41 | 88.42 | 88.43 | 88.43 | 88.43 |
| MRR | 88.48 | 88.50 | 88.51 | 88.52 | 88.53 | 88.54 | 88.54 | 88.54 |
| MRI | 88.60 | 88.61 | 88.62 | 88.63 | 88.64 | 88.65 | 88.65 | 88.65 |
| MRI | 88.71 | 88.72 | 88.73 | 88.74 | 88.75 | 88.76 | 88.76 | 88.76 |
| MRI | 88.82 | 88.83 | 88.84 | 88.85 | 88.86 | 88.87 | 88.87 | 88.87 |
| MRI | 88.93 | 88.94 | 88.95 | 88.96 | 88.97 | 88.98 | 88.98 | 88.98 |
| MRI | 89.04 | 89.05 | 89.06 | 89.07 | 89.08 | 89.09 | 89.09 | 89.09 |
| MRS | 89.15 | 89.16 | 89.17 | 89.18 | 89.19 | 89.20 | 89.20 | 89.20 |
| MRI | 89.26 | 89.27 | 89.28 | 89.29 | 89.30 | 89.31 | 89.31 | 89.31 |
| MRI | 89.37 | 89.39 | 89.40 | 89.41 | 89.42 | 89.43 | 89.43 | 89.43 |
| MRI | 89.48 | 89.49 | 89.50 | 89.51 | 89.52 | 89.53 | 89.53 | 89.53 |
| MRI | 89.58 | 89.59 | 89.60 | 89.61 | 89.62 | 89.63 | 89.63 | 89.63 |
| MRI | 89.69 | 89.71 | 89.72 | 89.73 | 89.74 | 89.75 | 89.75 | 89.75 |
| MRI | 89.80 | 89.81 | 89.82 | 89.83 | 89.84 | 89.85 | 89.85 | 89.85 |
| MRI | 89.91 | 89.92 | 89.93 | 89.94 | 89.95 | 89.96 | 89.96 | 89.96 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

3

4

PAGE 6

DATE 21 OCT 76

S/N 020

ALTITUDE IN THOUSANDS OF FEET

| S   | U     | R     | M     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|
| MDS | 90.01 | 90.03 | 90.04 | 90.05 | 90.07 | 90.09 | 90.10 |
| MDS | 90.13 | 90.14 | 90.15 | 90.17 | 90.18 | 90.20 | 90.22 |
| MDS | 90.24 | 90.25 | 90.26 | 90.27 | 90.28 | 90.30 | 90.32 |
| MDS | 90.34 | 90.35 | 90.36 | 90.37 | 90.38 | 90.40 | 90.42 |
| MDS | 90.45 | 90.46 | 90.47 | 90.48 | 90.49 | 90.50 | 90.52 |
| MDS | 90.55 | 90.56 | 90.57 | 90.58 | 90.59 | 90.60 | 90.62 |
| MDS | 90.66 | 90.67 | 90.68 | 90.69 | 90.70 | 90.72 | 90.74 |
| MDS | 90.76 | 90.77 | 90.78 | 90.79 | 90.80 | 90.82 | 90.84 |
| MDS | 90.87 | 90.88 | 90.89 | 90.90 | 90.91 | 90.92 | 90.94 |
| MDS | 90.97 | 90.98 | 90.99 | 91.00 | 91.01 | 91.02 | 91.04 |
| MDS | 91.07 | 91.08 | 91.09 | 91.10 | 91.11 | 91.12 | 91.14 |
| MDS | 91.18 | 91.19 | 91.20 | 91.21 | 91.22 | 91.23 | 91.24 |
| MDS | 91.28 | 91.29 | 91.30 | 91.31 | 91.32 | 91.33 | 91.34 |
| MDS | 91.38 | 91.39 | 91.40 | 91.41 | 91.42 | 91.43 | 91.44 |
| MDS | 91.48 | 91.49 | 91.50 | 91.51 | 91.52 | 91.53 | 91.54 |
| MDS | 91.59 | 91.60 | 91.61 | 91.62 | 91.63 | 91.64 | 91.65 |
| MDS | 91.69 | 91.70 | 91.71 | 91.72 | 91.73 | 91.74 | 91.75 |
| MDS | 91.79 | 91.80 | 91.81 | 91.82 | 91.83 | 91.84 | 91.85 |
| MDS | 91.89 | 91.90 | 91.91 | 91.92 | 91.93 | 91.94 | 91.95 |
| MDS | 91.99 | 92.00 | 92.01 | 92.02 | 92.03 | 92.04 | 92.05 |
| MDS | 92.08 | 92.09 | 92.10 | 92.11 | 92.12 | 92.13 | 92.14 |
| MDS | 92.18 | 92.19 | 92.20 | 92.21 | 92.22 | 92.23 | 92.24 |
| MDS | 92.28 | 92.29 | 92.30 | 92.31 | 92.32 | 92.33 | 92.34 |
| MDS | 92.38 | 92.39 | 92.40 | 92.41 | 92.42 | 92.43 | 92.44 |
| MDS | 92.48 | 92.49 | 92.50 | 92.51 | 92.52 | 92.53 | 92.54 |
| MDS | 92.58 | 92.59 | 92.60 | 92.61 | 92.62 | 92.63 | 92.64 |
| MDS | 92.67 | 92.68 | 92.69 | 92.70 | 92.71 | 92.72 | 92.73 |
| MDS | 92.77 | 92.78 | 92.79 | 92.80 | 92.81 | 92.82 | 92.83 |
| MDS | 92.87 | 92.88 | 92.89 | 92.90 | 92.91 | 92.92 | 92.93 |
| MDS | 92.97 | 92.98 | 92.99 | 93.00 | 93.01 | 93.02 | 93.03 |
| MDS | 93.06 | 93.07 | 93.08 | 93.09 | 93.10 | 93.11 | 93.12 |
| MDS | 93.16 | 93.17 | 93.18 | 93.19 | 93.20 | 93.21 | 93.22 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

B

A

PAGE 9

DATE 21 OCT 75

8-60 CALIBRATION RESULTS SAM 020

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | R     | M     | N     | K     | G     | O     |       |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| CSS | 93.26 | 93.27 | 93.28 | 93.29 | 93.30 | 93.32 | 93.33 | 93.34 | 93.35 |
| DSU | 93.35 | 93.36 | 93.38 | 93.39 | 93.40 | 93.41 | 93.42 | 93.43 | 93.44 |
| DSW | 93.45 | 93.46 | 93.47 | 93.48 | 93.49 | 93.50 | 93.51 | 93.52 | 93.53 |
| DSM | 93.54 | 93.55 | 93.57 | 93.58 | 93.59 | 93.60 | 93.62 | 93.63 | 93.64 |
| DSO | 93.64 | 93.65 | 93.66 | 93.67 | 93.68 | 93.70 | 93.71 | 93.72 | 93.73 |
| DSK | 93.73 | 93.75 | 93.76 | 93.77 | 93.78 | 93.79 | 93.80 | 93.82 | 93.83 |
| DSG | 93.83 | 93.84 | 93.85 | 93.86 | 93.88 | 93.89 | 93.90 | 93.91 | 93.92 |
| DSO | 93.92 | 93.93 | 93.95 | 93.96 | 93.97 | 93.98 | 93.99 | 94.00 | 94.01 |
| DUS | 94.02 | 94.03 | 94.04 | 94.05 | 94.06 | 94.07 | 94.08 | 94.09 | 94.10 |
| DUR | 94.10 | 94.12 | 94.13 | 94.14 | 94.15 | 94.16 | 94.17 | 94.18 | 94.19 |
| DUN | 94.20 | 94.21 | 94.22 | 94.23 | 94.24 | 94.25 | 94.27 | 94.28 | 94.29 |
| DUD | 94.29 | 94.30 | 94.31 | 94.32 | 94.34 | 94.35 | 94.36 | 94.37 | 94.38 |
| DUG | 94.38 | 94.39 | 94.40 | 94.42 | 94.43 | 94.44 | 94.45 | 94.46 | 94.47 |
| DUK | 94.47 | 94.48 | 94.49 | 94.50 | 94.51 | 94.52 | 94.53 | 94.54 | 94.55 |
| DUC | 94.57 | 94.58 | 94.59 | 94.60 | 94.61 | 94.62 | 94.63 | 94.64 | 94.65 |
| DUG | 94.66 | 94.67 | 94.68 | 94.69 | 94.70 | 94.71 | 94.72 | 94.73 | 94.74 |
| DRS | 94.75 | 94.76 | 94.77 | 94.78 | 94.79 | 94.81 | 94.82 | 94.83 | 94.84 |
| DRU | 94.84 | 94.85 | 94.86 | 94.87 | 94.88 | 94.89 | 94.90 | 94.91 | 94.92 |
| DRW | 94.93 | 94.95 | 94.96 | 94.97 | 94.98 | 94.99 | 95.00 | 95.01 | 95.02 |
| DRM | 95.02 | 95.04 | 95.05 | 95.06 | 95.07 | 95.08 | 95.09 | 95.10 | 95.11 |
| DRD | 95.11 | 95.13 | 95.14 | 95.15 | 95.16 | 95.17 | 95.18 | 95.19 | 95.20 |
| DRK | 95.20 | 95.22 | 95.23 | 95.24 | 95.25 | 95.26 | 95.27 | 95.28 | 95.29 |
| DRG | 95.29 | 95.31 | 95.32 | 95.33 | 95.34 | 95.35 | 95.36 | 95.37 | 95.38 |
| DRO | 95.38 | 95.39 | 95.41 | 95.42 | 95.43 | 95.44 | 95.45 | 95.46 | 95.47 |
| DNS | 95.47 | 95.48 | 95.49 | 95.51 | 95.52 | 95.53 | 95.54 | 95.55 | 95.56 |
| DMU | 95.56 | 95.57 | 95.58 | 95.59 | 95.61 | 95.62 | 95.63 | 95.64 | 95.65 |
| DMR | 95.65 | 95.66 | 95.67 | 95.68 | 95.69 | 95.70 | 95.71 | 95.72 | 95.73 |
| DMW | 95.74 | 95.75 | 95.76 | 95.77 | 95.78 | 95.79 | 95.80 | 95.81 | 95.82 |
| DMO | 95.82 | 95.84 | 95.85 | 95.86 | 95.87 | 95.88 | 95.89 | 95.90 | 95.91 |
| DMK | 95.91 | 95.92 | 95.93 | 95.94 | 95.95 | 95.96 | 95.97 | 95.98 | 95.99 |
| DMS | 95.99 | 96.01 | 96.02 | 96.03 | 96.04 | 96.05 | 96.06 | 96.07 | 96.08 |
| DNG | 96.08 | 96.09 | 96.10 | 96.12 | 96.13 | 96.14 | 96.15 | 96.16 | 96.17 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | P     | M     | D     | K     | G     | O     |            |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|------------|
| 003 | 96.17 | 96.18 | 96.19 | 96.20 | 96.21 | 96.22 | 96.23 | 96.24 | 3377300.00 |
| 004 | 96.26 | 96.27 | 96.28 | 96.29 | 96.30 | 96.31 | 96.32 | 96.33 | 3377300.00 |
| 005 | 96.34 | 96.35 | 96.36 | 96.37 | 96.38 | 96.39 | 96.40 | 96.41 | 3377300.00 |
| 006 | 96.43 | 96.44 | 96.45 | 96.46 | 96.47 | 96.48 | 96.49 | 96.50 | 3377300.00 |
| 007 | 96.51 | 96.52 | 96.53 | 96.54 | 96.55 | 96.56 | 96.57 | 96.58 | 3377300.00 |
| 008 | 96.60 | 96.61 | 96.62 | 96.63 | 96.64 | 96.65 | 96.66 | 96.67 | 3377300.00 |
| 009 | 96.68 | 96.69 | 96.70 | 96.71 | 96.72 | 96.73 | 96.74 | 96.75 | 3377300.00 |
| 010 | 96.77 | 96.78 | 96.79 | 96.80 | 96.81 | 96.82 | 96.83 | 96.84 | 3377300.00 |
| 011 | 96.85 | 96.86 | 96.87 | 96.88 | 96.89 | 96.90 | 96.91 | 96.92 | 3377300.00 |
| 012 | 96.94 | 96.95 | 96.96 | 96.97 | 96.98 | 96.99 | 97.00 | 97.01 | 3377300.00 |
| 013 | 97.02 | 97.03 | 97.04 | 97.05 | 97.06 | 97.07 | 97.08 | 97.09 | 3377300.00 |
| 014 | 97.11 | 97.12 | 97.13 | 97.14 | 97.15 | 97.16 | 97.17 | 97.18 | 3377300.00 |
| 015 | 97.19 | 97.20 | 97.21 | 97.22 | 97.23 | 97.24 | 97.25 | 97.26 | 3377300.00 |
| 016 | 97.27 | 97.28 | 97.29 | 97.30 | 97.31 | 97.32 | 97.33 | 97.34 | 3377300.00 |
| 017 | 97.36 | 97.37 | 97.38 | 97.39 | 97.40 | 97.41 | 97.42 | 97.43 | 3377300.00 |
| 018 | 97.44 | 97.45 | 97.46 | 97.47 | 97.48 | 97.49 | 97.50 | 97.51 | 3377300.00 |
| 019 | 97.52 | 97.53 | 97.54 | 97.55 | 97.56 | 97.57 | 97.58 | 97.59 | 3377300.00 |
| 020 | 97.61 | 97.62 | 97.63 | 97.64 | 97.65 | 97.66 | 97.67 | 97.68 | 3377300.00 |
| 021 | 97.69 | 97.70 | 97.71 | 97.72 | 97.73 | 97.74 | 97.75 | 97.76 | 3377300.00 |
| 022 | 97.77 | 97.78 | 97.79 | 97.80 | 97.81 | 97.82 | 97.83 | 97.84 | 3377300.00 |
| 023 | 97.85 | 97.86 | 97.87 | 97.88 | 97.89 | 97.90 | 97.91 | 97.92 | 3377300.00 |
| 024 | 97.93 | 97.94 | 97.95 | 97.96 | 97.97 | 97.98 | 97.99 | 98.00 | 3377300.00 |
| 025 | 98.01 | 98.02 | 98.03 | 98.04 | 98.05 | 98.06 | 98.07 | 98.08 | 3377300.00 |
| 026 | 98.10 | 98.11 | 98.12 | 98.13 | 98.14 | 98.15 | 98.16 | 98.17 | 3377300.00 |
| 027 | 98.18 | 98.19 | 98.20 | 98.21 | 98.22 | 98.23 | 98.24 | 98.25 | 3377300.00 |
| 028 | 98.26 | 98.27 | 98.28 | 98.29 | 98.30 | 98.31 | 98.32 | 98.33 | 3377300.00 |
| 029 | 98.34 | 98.35 | 98.36 | 98.37 | 98.38 | 98.39 | 98.40 | 98.41 | 3377300.00 |
| 030 | 98.42 | 98.43 | 98.44 | 98.45 | 98.46 | 98.47 | 98.48 | 98.49 | 3377300.00 |
| 031 | 98.50 | 98.51 | 98.52 | 98.53 | 98.54 | 98.55 | 98.56 | 98.57 | 3377300.00 |
| 032 | 98.58 | 98.59 | 98.60 | 98.61 | 98.62 | 98.63 | 98.64 | 98.65 | 3377300.00 |
| 033 | 98.66 | 98.67 | 98.68 | 98.69 | 98.70 | 98.71 | 98.72 | 98.73 | 3377300.00 |
| 034 | 98.74 | 98.75 | 98.76 | 98.77 | 98.78 | 98.79 | 98.80 | 98.81 | 3377300.00 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ALTITUDE IN THOUSANDS OF FEET

| S   | U      | R      | M      | D      | K      | G      | O      |        |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| KSS | 98.81  | 98.82  | 98.83  | 98.84  | 98.85  | 98.86  | 98.87  | 98.88  |
| KSU | 98.89  | 98.90  | 98.91  | 98.92  | 98.93  | 98.94  | 98.95  | 98.96  |
| KSR | 98.97  | 98.98  | 98.99  | 99.00  | 99.01  | 99.02  | 99.03  | 99.04  |
| KSM | 99.05  | 99.06  | 99.07  | 99.08  | 99.09  | 99.10  | 99.11  | 99.12  |
| KSD | 99.13  | 99.14  | 99.15  | 99.16  | 99.17  | 99.18  | 99.19  | 99.20  |
| KSE | 99.21  | 99.22  | 99.23  | 99.24  | 99.25  | 99.26  | 99.27  | 99.28  |
| KSF | 99.29  | 99.30  | 99.31  | 99.32  | 99.33  | 99.34  | 99.35  | 99.36  |
| KSG | 99.37  | 99.38  | 99.39  | 99.40  | 99.41  | 99.42  | 99.43  | 99.44  |
| KSH | 99.45  | 99.46  | 99.47  | 99.48  | 99.49  | 99.50  | 99.51  | 99.52  |
| KSI | 99.53  | 99.54  | 99.55  | 99.56  | 99.57  | 99.58  | 99.59  | 99.60  |
| KSM | 99.61  | 99.62  | 99.63  | 99.64  | 99.65  | 99.66  | 99.67  | 99.68  |
| KSN | 99.69  | 99.70  | 99.71  | 99.72  | 99.73  | 99.74  | 99.75  | 99.76  |
| KSO | 99.77  | 99.78  | 99.79  | 99.80  | 99.81  | 99.82  | 99.83  | 99.84  |
| KSP | 99.85  | 99.86  | 99.87  | 99.88  | 99.89  | 99.90  | 99.91  | 99.92  |
| KSQ | 99.93  | 99.94  | 99.95  | 99.96  | 99.97  | 99.98  | 99.99  | 100.00 |
| KSR | 100.01 | 100.02 | 100.03 | 100.04 | 100.05 | 100.06 | 100.07 | 100.08 |
| KSS | 100.09 | 100.10 | 100.11 | 100.12 | 100.13 | 100.14 | 100.15 | 100.16 |
| KSU | 100.17 | 100.18 | 100.19 | 100.20 | 100.21 | 100.22 | 100.23 | 100.24 |
| KSV | 100.25 | 100.26 | 100.27 | 100.28 | 100.29 | 100.30 | 100.31 | 100.32 |
| KSW | 100.33 | 100.34 | 100.35 | 100.36 | 100.37 | 100.38 | 100.39 | 100.40 |
| KSX | 100.41 | 100.42 | 100.43 | 100.44 | 100.45 | 100.46 | 100.47 | 100.48 |
| KSY | 100.49 | 100.50 | 100.51 | 100.52 | 100.53 | 100.54 | 100.55 | 100.56 |
| KSZ | 100.57 | 100.58 | 100.59 | 100.60 | 100.61 | 100.62 | 100.63 | 100.64 |
| KTA | 100.65 | 100.66 | 100.67 | 100.68 | 100.69 | 100.70 | 100.71 | 100.72 |
| KTB | 100.73 | 100.74 | 100.75 | 100.76 | 100.77 | 100.78 | 100.79 | 100.80 |
| KTC | 100.81 | 100.82 | 100.83 | 100.84 | 100.85 | 100.86 | 100.87 | 100.88 |
| KTD | 100.89 | 100.90 | 100.91 | 100.92 | 100.93 | 100.94 | 100.95 | 100.96 |
| KTE | 100.97 | 100.98 | 100.99 | 101.00 | 101.01 | 101.02 | 101.03 | 101.04 |
| KTF | 101.05 | 101.06 | 101.07 | 101.08 | 101.09 | 101.10 | 101.11 | 101.12 |
| KTG | 101.13 | 101.14 | 101.15 | 101.16 | 101.17 | 101.18 | 101.19 | 101.20 |
| KTH | 101.21 | 101.22 | 101.23 | 101.24 | 101.25 | 101.26 | 101.27 | 101.28 |
| KTI | 101.29 | 101.30 | 101.31 | 101.32 | 101.33 | 101.34 | 101.35 | 101.36 |
| KTJ | 101.37 | 101.38 | 101.39 | 101.40 | 101.41 | 101.42 | 101.43 | 101.44 |
| KTK | 101.45 | 101.46 | 101.47 | 101.48 | 101.49 | 101.50 | 101.51 | 101.52 |
| KTU | 101.53 | 101.54 | 101.55 | 101.56 | 101.57 | 101.58 | 101.59 | 101.60 |
| KTV | 101.61 | 101.62 | 101.63 | 101.64 | 101.65 | 101.66 | 101.67 | 101.68 |
| KTW | 101.69 | 101.70 | 101.71 | 101.72 | 101.73 | 101.74 | 101.75 | 101.76 |
| KTX | 101.77 | 101.78 | 101.79 | 101.80 | 101.81 | 101.82 | 101.83 | 101.84 |
| KTY | 101.85 | 101.86 | 101.87 | 101.88 | 101.89 | 101.90 | 101.91 | 101.92 |
| KTZ | 101.93 | 101.94 | 101.95 | 101.96 | 101.97 | 101.98 | 101.99 | 102.00 |
| KUA | 102.01 | 102.02 | 102.03 | 102.04 | 102.05 | 102.06 | 102.07 | 102.08 |
| KUB | 102.09 | 102.10 | 102.11 | 102.12 | 102.13 | 102.14 | 102.15 | 102.16 |
| KUC | 102.17 | 102.18 | 102.19 | 102.20 | 102.21 | 102.22 | 102.23 | 102.24 |
| KUD | 102.25 | 102.26 | 102.27 | 102.28 | 102.29 | 102.30 | 102.31 | 102.32 |
| KUE | 102.33 | 102.34 | 102.35 | 102.36 | 102.37 | 102.38 | 102.39 | 102.40 |
| KUF | 102.41 | 102.42 | 102.43 | 102.44 | 102.45 | 102.46 | 102.47 | 102.48 |
| KUG | 102.49 | 102.50 | 102.51 | 102.52 | 102.53 | 102.54 | 102.55 | 102.56 |
| KUH | 102.57 | 102.58 | 102.59 | 102.60 | 102.61 | 102.62 | 102.63 | 102.64 |
| KUI | 102.65 | 102.66 | 102.67 | 102.68 | 102.69 | 102.70 | 102.71 | 102.72 |
| KUJ | 102.73 | 102.74 | 102.75 | 102.76 | 102.77 | 102.78 | 102.79 | 102.80 |
| KUK | 102.81 | 102.82 | 102.83 | 102.84 | 102.85 | 102.86 | 102.87 | 102.88 |
| KUL | 102.89 | 102.90 | 102.91 | 102.92 | 102.93 | 102.94 | 102.95 | 102.96 |
| KUM | 102.97 | 102.98 | 102.99 | 103.00 | 103.01 | 103.02 | 103.03 | 103.04 |
| KUN | 103.05 | 103.06 | 103.07 | 103.08 | 103.09 | 103.10 | 103.11 | 103.12 |
| KUO | 103.13 | 103.14 | 103.15 | 103.16 | 103.17 | 103.18 | 103.19 | 103.20 |
| KUP | 103.21 | 103.22 | 103.23 | 103.24 | 103.25 | 103.26 | 103.27 | 103.28 |
| KUQ | 103.29 | 103.30 | 103.31 | 103.32 | 103.33 | 103.34 | 103.35 | 103.36 |
| KUR | 103.37 | 103.38 | 103.39 | 103.40 | 103.41 | 103.42 | 103.43 | 103.44 |
| KUS | 103.45 | 103.46 | 103.47 | 103.48 | 103.49 | 103.50 | 103.51 | 103.52 |
| KUT | 103.53 | 103.54 | 103.55 | 103.56 | 103.57 | 103.58 | 103.59 | 103.60 |
| KUV | 103.61 | 103.62 | 103.63 | 103.64 | 103.65 | 103.66 | 103.67 | 103.68 |
| KUW | 103.69 | 103.70 | 103.71 | 103.72 | 103.73 | 103.74 | 103.75 | 103.76 |
| KUX | 103.77 | 103.78 | 103.79 | 103.80 | 103.81 | 103.82 | 103.83 | 103.84 |
| KUY | 103.85 | 103.86 | 103.87 | 103.88 | 103.89 | 103.90 | 103.91 | 103.92 |
| KUZ | 103.93 | 103.94 | 103.95 | 103.96 | 103.97 | 103.98 | 103.99 | 104.00 |
| KVA | 104.01 | 104.02 | 104.03 | 104.04 | 104.05 | 104.06 | 104.07 | 104.08 |
| KVB | 104.09 | 104.10 | 104.11 | 104.12 | 104.13 | 104.14 | 104.15 | 104.16 |
| KVC | 104.17 | 104.18 | 104.19 | 104.20 | 104.21 | 104.22 | 104.23 | 104.24 |
| KVD | 104.25 | 104.26 | 104.27 | 104.28 | 104.29 | 104.30 | 104.31 | 104.32 |
| KVE | 104.33 | 104.34 | 104.35 | 104.36 | 104.37 | 104.38 | 104.39 | 104.40 |
| KVF | 104.41 | 104.42 | 104.43 | 104.44 | 104.45 | 104.46 | 104.47 | 104.48 |
| KVG | 104.49 | 104.50 | 104.51 | 104.52 | 104.53 | 104.54 | 104.55 | 104.56 |
| KVH | 104.57 | 104.58 | 104.59 | 104.60 | 104.61 | 104.62 | 104.63 | 104.64 |
| KVI | 104.65 | 104.66 | 104.67 | 104.68 | 104.69 | 104.70 | 104.71 | 104.72 |
| KVJ | 104.73 | 104.74 | 104.75 | 104.76 | 104.77 | 104.78 | 104.79 | 104.80 |
| KVK | 104.81 | 104.82 | 104.83 | 104.84 | 104.85 | 104.86 | 104.87 | 104.88 |
| KVL | 104.89 | 104.90 | 104.91 | 104.92 | 104.93 | 104.94 | 104.95 | 104.96 |
| KVM | 104.97 | 104.98 | 104.99 | 105.00 | 105.01 | 105.02 | 105.03 | 105.04 |
| KVN | 105.05 | 105.06 | 105.07 | 105.08 | 105.09 | 105.10 | 105.11 | 105.12 |
| KVO | 105.13 | 105.14 | 105.15 | 105.16 | 105.17 | 105.18 | 105.19 | 105.20 |
| KVP | 105.21 | 105.22 | 105.23 | 105.24 | 105.25 | 105.26 | 105.27 | 105.28 |
| KVQ | 105.29 | 105.30 | 105.31 | 105.32 | 105.33 | 105.34 | 105.35 | 105.36 |
| KVR | 105.37 | 105.38 | 105.39 | 105.40 | 105.41 | 105.42 | 105.43 | 105.44 |
| KVS | 105.45 | 105.46 | 105.47 | 105.48 | 105.49 | 105.50 | 105.51 | 105.52 |
| KVT | 105.53 | 105.54 | 105.55 | 105.56 | 105.57 | 105.58 | 105.59 | 105.60 |
| KVU | 105.61 | 105.62 | 105.63 | 105.64 | 105.65 | 105.66 | 105.67 | 105.68 |
| KVV | 105.69 | 105.70 | 105.71 | 105.72 | 105.73 | 105.74 | 105.75 | 105.76 |
| KVW | 105.77 | 105.78 | 105.79 | 105.80 | 105.81 | 105.82 | 105.83 | 105.84 |
| KVX | 105.85 | 105.86 | 105.87 | 105.88 | 105.89 | 105.90 | 105.91 | 105.92 |
| KVY | 105.93 | 105.94 | 105.95 | 105.96 | 105.97 | 105.98 | 105.99 | 106.00 |
| KVZ | 106.01 | 106.02 | 106.03 | 106.04 | 106.05 | 106.06 | 106.07 | 106.08 |
| KWA | 106.09 | 106.10 | 106.11 | 106.12 | 106.13 | 106.14 | 106.15 | 106.16 |
| KWB | 106.17 | 106.18 | 106.19 | 106.20 | 106.21 | 106.22 | 106.23 | 106.24 |
| KWC | 106.25 | 106.26 | 106.27 | 106.28 | 106.29 | 106.30 | 106.31 | 106.32 |
| KWD | 106.33 | 106.34 | 106.35 | 106.36 | 106.37 | 106.38 | 106.39 | 106.40 |
| KWE | 106.41 | 106.42 | 106.43 | 106.44 | 106.45 | 106.46 | 106.47 | 106.48 |
| KWF | 106.49 | 106.50 | 106.51 | 106.52 | 106.53 | 106.54 | 106.55 | 106.56 |
| KWG | 106.57 | 106.58 | 106.59 | 106.60 | 106.61 | 106.62 | 106.63 | 106.64 |
| KWH | 106.65 | 106.66 | 106.67 | 106.68 | 106.69 | 106.70 | 106.71 | 106.72 |
| KWI | 106.73 | 106.74 | 106.75 | 106.76 | 106.77 | 106.78 | 106.79 | 106.80 |
| KWJ | 106.81 | 106.82 | 106.83 | 106.84 | 106.85 | 106.86 | 106.87 | 106.88 |
| KWK | 106.89 | 106.90 | 106.91 | 106.92 | 106.93 | 106.94 | 106.95 | 106.96 |
| KWL | 106.97 | 106.98 | 106.99 | 107.00 | 107.01 | 107.02 | 107.03 | 107.04 |
| KWM | 107.05 | 107.06 | 107.07 | 107.08 | 107.09 | 107.10 | 107.11 | 107.12 |
| KWN | 107.13 | 107.14 | 107.15 | 107.16 | 107.17 | 107.18 | 107.19 | 107.20 |
| KWO | 107.21 | 107.22 | 107.23 | 107.24 | 107.25 | 107.26 | 107.27 | 107.28 |
| KWP | 107.29 | 107.30 | 107.31 | 107.32 | 107.33 | 107.34 | 107.35 | 107.36 |
| KWQ | 107.37 | 107.38 | 107.39 | 107.40 | 107.41 | 107.42 | 107.43 | 107.44 |
| KWR | 107.45 | 107.46 | 107.47 | 107.48 | 107.49 | 107.50 | 107.51 | 107.52 |
| KWS | 107.53 | 107.54 | 107.55 | 107.56 | 107.57 | 107.58 | 107.59 | 107.60 |
| KWT | 107.61 | 107.62 | 107.63 | 107.64 | 107.65 | 107.66 | 107.67 | 107.68 |
| KWU | 107.69 | 107.70 | 107.71 | 107.72 | 107.73 | 107.74 | 107.75 | 107.76 |
| KWV | 107.77 | 107.78 | 107.79 | 107.80 | 107.81 | 107.82 | 107.83 | 107.84 |
| KWW | 107.85 | 107.86 | 107.87 | 107.88 | 107.89 | 107.90 | 107.91 | 107.92 |
| KWX | 107.93 | 107.94 | 107.95 | 107.96 | 107.97 | 107.98 | 107.99 | 108.00 |
| KWY | 108.01 | 108.02 | 108.03 | 108.04 | 108.05 | 108.06 | 108.07 | 108.08 |
| KWZ | 108.09 | 108.10 | 108.11 | 108.12 | 108.13 | 108.14 | 108.15 | 108.16 |
| KXA | 108.17 | 108.18 | 108.19 | 108.20 | 108.21 | 108.22 | 108.23 | 108.24 |
| KXB | 108.25 | 108.26 | 108.27 | 108.28 | 108.29 | 108.30 | 108.31 | 108.32 |
| KXC | 108.33 | 108.34 | 108.35 | 108.36 | 108.37 | 108.38 | 108.39 | 108.40 |
| KXD | 108.41 | 108.42 | 108.43 | 108.44 | 108.45 | 108.46 | 108.47 | 108.48 |
| KXE | 108.49 | 108.50 | 108.51 | 108.52 |        |        |        |        |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

B-60 CALIBRATION RESULTS S/N 020 DATE 21 OCT 76 PAGE 12

ALTITUDE IN THOUSANDS OF FEET

|     | S      | U      | R      | M      | D      | K      | G      | O      | A | B |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|---|---|
| KOS | 101.22 | 101.23 | 101.24 | 101.25 | 101.26 | 101.27 | 101.28 | 101.29 |   |   |
| KOU | 101.30 | 101.31 | 101.32 | 101.33 | 101.34 | 101.35 | 101.36 | 101.37 |   |   |
| KOF | 101.37 | 101.38 | 101.39 | 101.40 | 101.41 | 101.42 | 101.43 | 101.44 |   |   |
| KOW | 101.44 | 101.45 | 101.46 | 101.47 | 101.48 | 101.49 | 101.50 | 101.51 |   |   |
| KOD | 101.51 | 101.52 | 101.53 | 101.54 | 101.55 | 101.56 | 101.57 | 101.58 |   |   |
| KOK | 101.58 | 101.59 | 101.60 | 101.61 | 101.62 | 101.63 | 101.64 | 101.65 |   |   |
| KOG | 101.66 | 101.67 | 101.68 | 101.69 | 101.70 | 101.71 | 101.72 | 101.73 |   |   |
| KDO | 101.73 | 101.74 | 101.75 | 101.76 | 101.77 | 101.78 | 101.79 | 101.80 |   |   |
| KKS | 101.80 | 101.81 | 101.82 | 101.83 | 101.84 | 101.85 | 101.86 | 101.87 |   |   |
| KKU | 101.87 | 101.88 | 101.89 | 101.90 | 101.91 | 101.92 | 101.93 | 101.94 |   |   |
| KKR | 101.94 | 101.95 | 101.96 | 101.97 | 101.98 | 101.99 | 102.00 | 102.01 |   |   |
| KKW | 102.02 | 102.03 | 102.04 | 102.05 | 102.06 | 102.07 | 102.08 | 102.09 |   |   |
| KKD | 102.09 | 102.10 | 102.11 | 102.12 | 102.13 | 102.14 | 102.15 | 102.16 |   |   |
| KKK | 102.16 | 102.17 | 102.18 | 102.19 | 102.20 | 102.21 | 102.22 | 102.23 |   |   |
| KKG | 102.23 | 102.24 | 102.25 | 102.26 | 102.27 | 102.28 | 102.29 | 102.30 |   |   |
| KKO | 102.30 | 102.31 | 102.32 | 102.33 | 102.34 | 102.35 | 102.36 | 102.37 |   |   |
| KGS | 102.37 | 102.38 | 102.39 | 102.40 | 102.41 | 102.42 | 102.43 | 102.44 |   |   |
| KGU | 102.44 | 102.45 | 102.46 | 102.47 | 102.48 | 102.49 | 102.50 | 102.51 |   |   |
| KGR | 102.51 | 102.52 | 102.53 | 102.54 | 102.55 | 102.56 | 102.57 | 102.58 |   |   |
| KGW | 102.58 | 102.59 | 102.60 | 102.61 | 102.62 | 102.63 | 102.64 | 102.65 |   |   |
| KGD | 102.65 | 102.66 | 102.67 | 102.68 | 102.69 | 102.70 | 102.71 | 102.72 |   |   |
| KGG | 102.72 | 102.73 | 102.74 | 102.75 | 102.76 | 102.77 | 102.78 | 102.79 |   |   |
| KGK | 102.79 | 102.80 | 102.81 | 102.82 | 102.83 | 102.84 | 102.85 | 102.86 |   |   |
| KGO | 102.86 | 102.87 | 102.88 | 102.89 | 102.90 | 102.91 | 102.92 | 102.93 |   |   |
| KOS | 102.93 | 102.94 | 102.95 | 102.96 | 102.97 | 102.98 | 102.99 | 103.00 |   |   |
| KOU | 103.00 | 103.01 | 103.02 | 103.03 | 103.04 | 103.05 | 103.06 | 103.07 |   |   |
| KOR | 103.06 | 103.07 | 103.08 | 103.09 | 103.10 | 103.11 | 103.12 | 103.13 |   |   |
| KOW | 103.12 | 103.13 | 103.14 | 103.15 | 103.16 | 103.17 | 103.18 | 103.19 |   |   |
| KOD | 103.19 | 103.20 | 103.21 | 103.22 | 103.23 | 103.24 | 103.25 | 103.26 |   |   |
| KOK | 103.26 | 103.27 | 103.28 | 103.29 | 103.30 | 103.31 | 103.32 | 103.33 |   |   |
| KOG | 103.33 | 103.34 | 103.35 | 103.36 | 103.37 | 103.38 | 103.39 | 103.40 |   |   |
| KDO | 103.40 | 103.41 | 103.42 | 103.43 | 103.44 | 103.45 | 103.46 | 103.47 |   |   |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

B-60 CALIBRATION RESULTS S/N 020 DATE 21 OCT 76 PAGE 13

ALTITUDE IN THOUSANDS OF FEET

|     | S      | U      | Q      | M      | D      | K      | G      | O      |        |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| GSS | 103.46 | 103.47 | 103.44 | 103.49 | 103.50 | 103.51 | 103.51 | 103.52 | 103.52 |
| GSU | 103.53 | 103.54 | 103.55 | 103.56 | 103.56 | 103.57 | 103.58 | 103.59 | 103.59 |
| GSW | 103.60 | 103.61 | 103.62 | 103.63 | 103.64 | 103.65 | 103.66 | 103.67 | 103.68 |
| GSX | 103.67 | 103.68 | 103.69 | 103.70 | 103.71 | 103.72 | 103.73 | 103.74 | 103.75 |
| GSD | 103.73 | 103.74 | 103.75 | 103.76 | 103.77 | 103.78 | 103.79 | 103.80 | 103.81 |
| GSK | 103.80 | 103.81 | 103.82 | 103.83 | 103.84 | 103.85 | 103.86 | 103.87 | 103.88 |
| GSG | 103.87 | 103.88 | 103.89 | 103.90 | 103.91 | 103.92 | 103.93 | 103.94 | 103.95 |
| GSO | 103.93 | 103.94 | 103.95 | 103.96 | 103.97 | 103.98 | 103.99 | 104.00 | 104.01 |
| GUS | 104.00 | 104.01 | 104.02 | 104.03 | 104.04 | 104.05 | 104.06 | 104.07 | 104.08 |
| GUV | 104.07 | 104.08 | 104.09 | 104.10 | 104.11 | 104.12 | 104.13 | 104.14 | 104.15 |
| GUR | 104.14 | 104.15 | 104.16 | 104.17 | 104.18 | 104.19 | 104.20 | 104.21 | 104.22 |
| GUM | 104.21 | 104.22 | 104.23 | 104.24 | 104.25 | 104.26 | 104.27 | 104.28 | 104.29 |
| GUD | 104.27 | 104.28 | 104.29 | 104.30 | 104.31 | 104.32 | 104.33 | 104.34 | 104.35 |
| GUK | 104.34 | 104.35 | 104.36 | 104.37 | 104.38 | 104.39 | 104.40 | 104.41 | 104.42 |
| GUG | 104.41 | 104.42 | 104.43 | 104.44 | 104.45 | 104.46 | 104.47 | 104.48 | 104.49 |
| GUD | 104.47 | 104.48 | 104.49 | 104.50 | 104.51 | 104.52 | 104.53 | 104.54 | 104.55 |
| GSS | 104.54 | 104.55 | 104.56 | 104.57 | 104.58 | 104.59 | 104.60 | 104.61 | 104.62 |
| GRU | 104.60 | 104.61 | 104.62 | 104.63 | 104.64 | 104.65 | 104.66 | 104.67 | 104.68 |
| GRR | 104.67 | 104.68 | 104.69 | 104.70 | 104.71 | 104.72 | 104.73 | 104.74 | 104.75 |
| GRM | 104.73 | 104.74 | 104.75 | 104.76 | 104.77 | 104.78 | 104.79 | 104.80 | 104.81 |
| GRD | 104.80 | 104.81 | 104.82 | 104.83 | 104.84 | 104.85 | 104.86 | 104.87 | 104.88 |
| GRK | 104.86 | 104.87 | 104.88 | 104.89 | 104.90 | 104.91 | 104.92 | 104.93 | 104.94 |
| GRG | 104.93 | 104.94 | 104.95 | 104.96 | 104.97 | 104.98 | 104.99 | 105.00 | 105.01 |
| GRU | 104.99 | 105.00 | 105.01 | 105.02 | 105.03 | 105.04 | 105.05 | 105.06 | 105.07 |
| GWS | 105.05 | 105.06 | 105.07 | 105.08 | 105.09 | 105.10 | 105.11 | 105.12 | 105.13 |
| GWU | 105.13 | 105.14 | 105.15 | 105.16 | 105.17 | 105.18 | 105.19 | 105.20 | 105.21 |
| GWR | 105.19 | 105.20 | 105.21 | 105.22 | 105.23 | 105.24 | 105.25 | 105.26 | 105.27 |
| GWM | 105.26 | 105.27 | 105.28 | 105.29 | 105.30 | 105.31 | 105.32 | 105.33 | 105.34 |
| GWD | 105.32 | 105.33 | 105.34 | 105.35 | 105.36 | 105.37 | 105.38 | 105.39 | 105.40 |
| GWK | 105.39 | 105.40 | 105.41 | 105.42 | 105.43 | 105.44 | 105.45 | 105.46 | 105.47 |
| GWG | 105.45 | 105.46 | 105.47 | 105.48 | 105.49 | 105.50 | 105.51 | 105.52 | 105.53 |
| GWO | 105.52 | 105.53 | 105.54 | 105.55 | 105.56 | 105.57 | 105.58 | 105.59 | 105.60 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

8-60 CALIBRATION RESULTS S/N 926 DATE 21 OCT 76 PAGE 14

ALTITUDE IN THOUSANDS OF FEET

|     | S      | U      | R      | M      | D      | K      | G      | O      |        |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| GDS | 105.58 | 105.59 | 105.60 | 105.61 | 105.62 | 105.63 | 105.64 | 105.65 | 105.66 |
| GDU | 105.65 | 105.66 | 105.67 | 105.68 | 105.69 | 105.70 | 105.71 | 105.72 | 105.73 |
| GDR | 105.71 | 105.72 | 105.73 | 105.74 | 105.75 | 105.76 | 105.77 | 105.78 | 105.79 |
| GDM | 105.77 | 105.78 | 105.79 | 105.80 | 105.81 | 105.82 | 105.83 | 105.84 | 105.85 |
| GDO | 105.84 | 105.85 | 105.86 | 105.87 | 105.88 | 105.89 | 105.90 | 105.91 | 105.92 |
| GDK | 105.90 | 105.91 | 105.92 | 105.93 | 105.94 | 105.95 | 105.96 | 105.97 | 105.98 |
| GDE | 105.96 | 105.97 | 105.98 | 105.99 | 106.00 | 106.01 | 106.02 | 106.03 | 106.04 |
| GDF | 106.03 | 106.04 | 106.05 | 106.06 | 106.07 | 106.08 | 106.09 | 106.10 | 106.11 |
| GDS | 106.08 | 106.09 | 106.10 | 106.11 | 106.12 | 106.13 | 106.14 | 106.15 | 106.16 |
| GDU | 106.15 | 106.16 | 106.17 | 106.18 | 106.19 | 106.20 | 106.21 | 106.22 | 106.23 |
| GDR | 106.21 | 106.22 | 106.23 | 106.24 | 106.25 | 106.26 | 106.27 | 106.28 | 106.29 |
| GDM | 106.27 | 106.28 | 106.29 | 106.30 | 106.31 | 106.32 | 106.33 | 106.34 | 106.35 |
| GDO | 106.34 | 106.35 | 106.36 | 106.37 | 106.38 | 106.39 | 106.40 | 106.41 | 106.42 |
| GDK | 106.40 | 106.41 | 106.42 | 106.43 | 106.44 | 106.45 | 106.46 | 106.47 | 106.48 |
| GDE | 106.46 | 106.47 | 106.48 | 106.49 | 106.50 | 106.51 | 106.52 | 106.53 | 106.54 |
| GDF | 106.52 | 106.53 | 106.54 | 106.55 | 106.56 | 106.57 | 106.58 | 106.59 | 106.60 |
| GDS | 106.58 | 106.59 | 106.60 | 106.61 | 106.62 | 106.63 | 106.64 | 106.65 | 106.66 |
| GDU | 106.65 | 106.66 | 106.67 | 106.68 | 106.69 | 106.70 | 106.71 | 106.72 | 106.73 |
| GDR | 106.71 | 106.72 | 106.73 | 106.74 | 106.75 | 106.76 | 106.77 | 106.78 | 106.79 |
| GDM | 106.77 | 106.78 | 106.79 | 106.80 | 106.81 | 106.82 | 106.83 | 106.84 | 106.85 |
| GDO | 106.84 | 106.85 | 106.86 | 106.87 | 106.88 | 106.89 | 106.90 | 106.91 | 106.92 |
| GDK | 106.89 | 106.90 | 106.91 | 106.92 | 106.93 | 106.94 | 106.95 | 106.96 | 106.97 |
| GDE | 106.95 | 106.96 | 106.97 | 106.98 | 106.99 | 107.00 | 107.01 | 107.02 | 107.03 |
| GDF | 107.01 | 107.02 | 107.03 | 107.04 | 107.05 | 107.06 | 107.07 | 107.08 | 107.09 |
| GDS | 107.08 | 107.09 | 107.10 | 107.11 | 107.12 | 107.13 | 107.14 | 107.15 | 107.16 |
| GDU | 107.14 | 107.15 | 107.16 | 107.17 | 107.18 | 107.19 | 107.20 | 107.21 | 107.22 |
| GDR | 107.20 | 107.21 | 107.22 | 107.23 | 107.24 | 107.25 | 107.26 | 107.27 | 107.28 |
| GDM | 107.26 | 107.27 | 107.28 | 107.29 | 107.30 | 107.31 | 107.32 | 107.33 | 107.34 |
| GDO | 107.33 | 107.34 | 107.35 | 107.36 | 107.37 | 107.38 | 107.39 | 107.40 | 107.41 |
| GDK | 107.39 | 107.40 | 107.41 | 107.42 | 107.43 | 107.44 | 107.45 | 107.46 | 107.47 |
| GDE | 107.45 | 107.46 | 107.47 | 107.48 | 107.49 | 107.50 | 107.51 | 107.52 | 107.53 |
| GDF | 107.51 | 107.52 | 107.53 | 107.54 | 107.55 | 107.56 | 107.57 | 107.58 | 107.59 |

B-60 CALIBRATION RESULTS S/N 020 DATE 21 OCT 76 PAGE 15

| ALTITUDE IN THOUSANDS OF FEET                               |   |   |   |   |   |   |   |  |  |  | A | B |
|-------------------------------------------------------------|---|---|---|---|---|---|---|--|--|--|---|---|
| S                                                           | U | O | M | C | K | G | O |  |  |  |   |   |
| OSS 107.57 107.58 107.59 107.59 107.60 107.61 107.62 107.62 |   |   |   |   |   |   |   |  |  |  |   |   |
| OSU 107.63 107.64 107.65 107.65 107.66 107.67 107.68 107.68 |   |   |   |   |   |   |   |  |  |  |   |   |
| OSR 107.69 107.70 107.71 107.71 107.72 107.73 107.74 107.74 |   |   |   |   |   |   |   |  |  |  |   |   |
| OSM 107.75 107.76 107.77 107.77 107.78 107.79 107.80 107.80 |   |   |   |   |   |   |   |  |  |  |   |   |
| OSD 107.81 107.82 107.83 107.83 107.84 107.85 107.86 107.86 |   |   |   |   |   |   |   |  |  |  |   |   |
| OSK 107.87 107.88 107.89 107.89 107.90 107.91 107.92 107.92 |   |   |   |   |   |   |   |  |  |  |   |   |
| OSG 107.93 107.94 107.95 107.95 107.96 107.97 107.98 107.98 |   |   |   |   |   |   |   |  |  |  |   |   |
| CSO 107.99 108.00 108.01 108.02 108.02 108.03 108.04 108.04 |   |   |   |   |   |   |   |  |  |  |   |   |
| OUS 108.05 108.06 108.07 108.08 108.08 108.09 108.10 108.10 |   |   |   |   |   |   |   |  |  |  |   |   |
| OUU 108.11 108.12 108.13 108.13 108.14 108.15 108.16 108.16 |   |   |   |   |   |   |   |  |  |  |   |   |
| OUP 108.19 108.19 108.20 108.21 108.22 108.22 108.23 108.23 |   |   |   |   |   |   |   |  |  |  |   |   |
| OUM 108.25 108.25 108.26 108.27 108.28 108.28 108.29 108.29 |   |   |   |   |   |   |   |  |  |  |   |   |
| OOD 108.31 108.31 108.32 108.33 108.34 108.34 108.35 108.35 |   |   |   |   |   |   |   |  |  |  |   |   |
| OUK 108.37 108.38 108.38 108.39 108.40 108.41 108.41 108.42 |   |   |   |   |   |   |   |  |  |  |   |   |
| OUG 108.43 108.44 108.44 108.45 108.46 108.47 108.47 108.48 |   |   |   |   |   |   |   |  |  |  |   |   |
| OUD 108.49 108.50 108.50 108.51 108.52 108.53 108.53 108.54 |   |   |   |   |   |   |   |  |  |  |   |   |
| ORS 108.55 108.56 108.56 108.57 108.58 108.59 108.59 108.60 |   |   |   |   |   |   |   |  |  |  |   |   |
| ORU 108.61 108.62 108.62 108.63 108.64 108.65 108.65 108.66 |   |   |   |   |   |   |   |  |  |  |   |   |
| ORR 108.67 108.68 108.68 108.69 108.70 108.71 108.71 108.72 |   |   |   |   |   |   |   |  |  |  |   |   |
| CRM 108.73 108.74 108.74 108.75 108.76 108.77 108.77 108.78 |   |   |   |   |   |   |   |  |  |  |   |   |
| ORD 108.79 108.80 108.80 108.81 108.82 108.83 108.83 108.84 |   |   |   |   |   |   |   |  |  |  |   |   |
| ORP 108.85 108.86 108.86 108.87 108.88 108.89 108.89 108.90 |   |   |   |   |   |   |   |  |  |  |   |   |
| ORC 108.91 108.92 108.92 108.93 108.94 108.95 108.95 108.96 |   |   |   |   |   |   |   |  |  |  |   |   |
| ORO 108.97 108.98 108.98 108.99 109.00 109.01 109.01 109.02 |   |   |   |   |   |   |   |  |  |  |   |   |
| ONS 109.02 109.03 109.04 109.05 109.05 109.06 109.07 109.08 |   |   |   |   |   |   |   |  |  |  |   |   |
| ONU 109.06 109.07 109.08 109.09 109.09 109.10 109.11 109.12 |   |   |   |   |   |   |   |  |  |  |   |   |
| ONR 109.12 109.13 109.14 109.14 109.15 109.16 109.17 109.18 |   |   |   |   |   |   |   |  |  |  |   |   |
| ONW 109.18 109.19 109.20 109.20 109.21 109.22 109.23 109.24 |   |   |   |   |   |   |   |  |  |  |   |   |
| CND 109.24 109.25 109.26 109.26 109.27 109.28 109.29 109.30 |   |   |   |   |   |   |   |  |  |  |   |   |
| ONK 109.30 109.31 109.31 109.32 109.33 109.34 109.34 109.35 |   |   |   |   |   |   |   |  |  |  |   |   |
| CNC 109.36 109.37 109.37 109.38 109.39 109.40 109.41 109.42 |   |   |   |   |   |   |   |  |  |  |   |   |
| ONW 109.42 109.43 109.44 109.44 109.45 109.46 109.46 109.47 |   |   |   |   |   |   |   |  |  |  |   |   |

ALTITUDE IN THOUSANDS OF FEET

|     | S      | U      | R      | M      | D      | K      | G      | O      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| 00S | 109.40 | 109.40 | 109.49 | 109.50 | 109.51 | 109.51 | 109.52 | 109.53 |
| 00U | 109.53 | 109.54 | 109.55 | 109.56 | 109.57 | 109.57 | 109.58 | 109.59 |
| 00R | 109.59 | 109.60 | 109.61 | 109.62 | 109.63 | 109.64 | 109.65 | 109.66 |
| 00M | 109.65 | 109.66 | 109.67 | 109.68 | 109.69 | 109.70 | 109.71 | 109.72 |
| 00K | 109.71 | 109.72 | 109.73 | 109.74 | 109.75 | 109.76 | 109.77 | 109.78 |
| 00J | 109.77 | 109.78 | 109.79 | 109.80 | 109.81 | 109.82 | 109.83 | 109.84 |
| 00I | 109.83 | 109.84 | 109.85 | 109.86 | 109.87 | 109.88 | 109.89 | 109.90 |
| 00H | 109.88 | 109.89 | 109.90 | 109.91 | 109.92 | 109.93 | 109.94 | 109.95 |
| 00G | 109.94 | 109.95 | 109.96 | 109.97 | 109.98 | 109.99 | 110.00 | 110.01 |
| 00F | 110.01 | 110.02 | 110.03 | 110.04 | 110.05 | 110.06 | 110.07 | 110.08 |
| 00E | 110.08 | 110.09 | 110.10 | 110.11 | 110.12 | 110.13 | 110.14 | 110.15 |
| 00D | 110.15 | 110.16 | 110.17 | 110.18 | 110.19 | 110.20 | 110.21 | 110.22 |
| 00C | 110.22 | 110.23 | 110.24 | 110.25 | 110.26 | 110.27 | 110.28 | 110.29 |
| 00B | 110.29 | 110.30 | 110.31 | 110.32 | 110.33 | 110.34 | 110.35 | 110.36 |
| 00A | 110.36 | 110.37 | 110.38 | 110.39 | 110.40 | 110.41 | 110.42 | 110.43 |
| 00Z | 110.43 | 110.44 | 110.45 | 110.46 | 110.47 | 110.48 | 110.49 | 110.50 |
| 00Y | 110.50 | 110.51 | 110.52 | 110.53 | 110.54 | 110.55 | 110.56 | 110.57 |
| 00X | 110.57 | 110.58 | 110.59 | 110.60 | 110.61 | 110.62 | 110.63 | 110.64 |
| 00W | 110.64 | 110.65 | 110.66 | 110.67 | 110.68 | 110.69 | 110.70 | 110.71 |
| 00V | 110.71 | 110.72 | 110.73 | 110.74 | 110.75 | 110.76 | 110.77 | 110.78 |
| 00U | 110.78 | 110.79 | 110.80 | 110.81 | 110.82 | 110.83 | 110.84 | 110.85 |
| 00T | 110.85 | 110.86 | 110.87 | 110.88 | 110.89 | 110.90 | 110.91 | 110.92 |
| 00S | 110.92 | 110.93 | 110.94 | 110.95 | 110.96 | 110.97 | 110.98 | 110.99 |
| 00R | 110.99 | 111.00 | 111.01 | 111.02 | 111.03 | 111.04 | 111.05 | 111.06 |
| 00Q | 111.06 | 111.07 | 111.08 | 111.09 | 111.10 | 111.11 | 111.12 | 111.13 |
| 00P | 111.13 | 111.14 | 111.15 | 111.16 | 111.17 | 111.18 | 111.19 | 111.20 |
| 00O | 111.20 | 111.21 | 111.22 | 111.23 | 111.24 | 111.25 | 111.26 | 111.27 |
| 00N | 111.27 | 111.28 | 111.29 | 111.30 | 111.31 | 111.32 | 111.33 | 111.34 |
| 00M | 111.34 | 111.35 | 111.36 | 111.37 | 111.38 | 111.39 | 111.40 | 111.41 |
| 00L | 111.41 | 111.42 | 111.43 | 111.44 | 111.45 | 111.46 | 111.47 | 111.48 |
| 00K | 111.48 | 111.49 | 111.50 | 111.51 | 111.52 | 111.53 | 111.54 | 111.55 |
| 00J | 111.55 | 111.56 | 111.57 | 111.58 | 111.59 | 111.60 | 111.61 | 111.62 |
| 00I | 111.62 | 111.63 | 111.64 | 111.65 | 111.66 | 111.67 | 111.68 | 111.69 |
| 00H | 111.69 | 111.70 | 111.71 | 111.72 | 111.73 | 111.74 | 111.75 | 111.76 |
| 00G | 111.76 | 111.77 | 111.78 | 111.79 | 111.80 | 111.81 | 111.82 | 111.83 |
| 00F | 111.83 | 111.84 | 111.85 | 111.86 | 111.87 | 111.88 | 111.89 | 111.90 |
| 00E | 111.90 | 111.91 | 111.92 | 111.93 | 111.94 | 111.95 | 111.96 | 111.97 |
| 00D | 111.97 | 111.98 | 111.99 | 112.00 | 112.01 | 112.02 | 112.03 | 112.04 |
| 00C | 112.04 | 112.05 | 112.06 | 112.07 | 112.08 | 112.09 | 112.10 | 112.11 |
| 00B | 112.11 | 112.12 | 112.13 | 112.14 | 112.15 | 112.16 | 112.17 | 112.18 |
| 00A | 112.18 | 112.19 | 112.20 | 112.21 | 112.22 | 112.23 | 112.24 | 112.25 |
| 00Z | 112.25 | 112.26 | 112.27 | 112.28 | 112.29 | 112.30 | 112.31 | 112.32 |
| 00Y | 112.32 | 112.33 | 112.34 | 112.35 | 112.36 | 112.37 | 112.38 | 112.39 |
| 00X | 112.39 | 112.40 | 112.41 | 112.42 | 112.43 | 112.44 | 112.45 | 112.46 |
| 00W | 112.46 | 112.47 | 112.48 | 112.49 | 112.50 | 112.51 | 112.52 | 112.53 |
| 00V | 112.53 | 112.54 | 112.55 | 112.56 | 112.57 | 112.58 | 112.59 | 112.60 |
| 00U | 112.60 | 112.61 | 112.62 | 112.63 | 112.64 | 112.65 | 112.66 | 112.67 |
| 00T | 112.67 | 112.68 | 112.69 | 112.70 | 112.71 | 112.72 | 112.73 | 112.74 |
| 00S | 112.74 | 112.75 | 112.76 | 112.77 | 112.78 | 112.79 | 112.80 | 112.81 |
| 00R | 112.81 | 112.82 | 112.83 | 112.84 | 112.85 | 112.86 | 112.87 | 112.88 |
| 00Q | 112.88 | 112.89 | 112.90 | 112.91 | 112.92 | 112.93 | 112.94 | 112.95 |
| 00P | 112.95 | 112.96 | 112.97 | 112.98 | 112.99 | 113.00 | 113.01 | 113.02 |
| 00O | 113.02 | 113.03 | 113.04 | 113.05 | 113.06 | 113.07 | 113.08 | 113.09 |
| 00N | 113.09 | 113.10 | 113.11 | 113.12 | 113.13 | 113.14 | 113.15 | 113.16 |
| 00M | 113.16 | 113.17 | 113.18 | 113.19 | 113.20 | 113.21 | 113.22 | 113.23 |
| 00L | 113.23 | 113.24 | 113.25 | 113.26 | 113.27 | 113.28 | 113.29 | 113.30 |
| 00K | 113.30 | 113.31 | 113.32 | 113.33 | 113.34 | 113.35 | 113.36 | 113.37 |
| 00J | 113.37 | 113.38 | 113.39 | 113.40 | 113.41 | 113.42 | 113.43 | 113.44 |
| 00I | 113.44 | 113.45 | 113.46 | 113.47 | 113.48 | 113.49 | 113.50 | 113.51 |
| 00H | 113.51 | 113.52 | 113.53 | 113.54 | 113.55 | 113.56 | 113.57 | 113.58 |
| 00G | 113.58 | 113.59 | 113.60 | 113.61 | 113.62 | 113.63 | 113.64 | 113.65 |
| 00F | 113.65 | 113.66 | 113.67 | 113.68 | 113.69 | 113.70 | 113.71 | 113.72 |
| 00E | 113.72 | 113.73 | 113.74 | 113.75 | 113.76 | 113.77 | 113.78 | 113.79 |
| 00D | 113.79 | 113.80 | 113.81 | 113.82 | 113.83 | 113.84 | 113.85 | 113.86 |
| 00C | 113.86 | 113.87 | 113.88 | 113.89 | 113.90 | 113.91 | 113.92 | 113.93 |
| 00B | 113.93 | 113.94 | 113.95 | 113.96 | 113.97 | 113.98 | 113.99 | 114.00 |
| 00A | 114.00 | 114.01 | 114.02 | 114.03 | 114.04 | 114.05 | 114.06 | 114.07 |
| 00Z | 114.07 | 114.08 | 114.09 | 114.10 | 114.11 | 114.12 | 114.13 | 114.14 |
| 00Y | 114.14 | 114.15 | 114.16 | 114.17 | 114.18 | 114.19 | 114.20 | 114.21 |
| 00X | 114.21 | 114.22 | 114.23 | 114.24 | 114.25 | 114.26 | 114.27 | 114.28 |
| 00W | 114.28 | 114.29 | 114.30 | 114.31 | 114.32 | 114.33 | 114.34 | 114.35 |
| 00V | 114.35 | 114.36 | 114.37 | 114.38 | 114.39 | 114.40 | 114.41 | 114.42 |
| 00U | 114.42 | 114.43 | 114.44 | 114.45 | 114.46 | 114.47 | 114.48 | 114.49 |
| 00T | 114.49 | 114.50 | 114.51 | 114.52 | 114.53 | 114.54 | 114.55 | 114.56 |
| 00S | 114.56 | 114.57 | 114.58 | 114.59 | 114.60 | 114.61 | 114.62 | 114.63 |
| 00R | 114.63 | 114.64 | 114.65 | 114.66 | 114.67 | 114.68 | 114.69 | 114.70 |
| 00Q | 114.70 | 114.71 | 114.72 | 114.73 | 114.74 | 114.75 | 114.76 | 114.77 |
| 00P | 114.77 | 114.78 | 114.79 | 114.80 | 114.81 | 114.82 | 114.83 | 114.84 |
| 00O | 114.84 | 114.85 | 114.86 | 114.87 | 114.88 | 114.89 | 114.90 | 114.91 |
| 00N | 114.91 | 114.92 | 114.93 | 114.94 | 114.95 | 114.96 | 114.97 | 114.98 |
| 00M | 114.98 | 114.99 | 115.00 | 115.01 | 115.02 | 115.03 | 115.04 | 115.05 |
| 00L | 115.05 | 115.06 | 115.07 | 115.08 | 115.09 | 115.10 | 115.11 | 115.12 |
| 00K | 115.12 | 115.13 | 115.14 | 115.15 | 115.16 | 115.17 | 115.18 | 115.19 |
| 00J | 115.19 | 115.20 | 115.21 | 115.22 | 115.23 | 115.24 | 115.25 | 115.26 |
| 00I | 115.26 | 115.27 | 115.28 | 115.29 | 115.30 | 115.31 | 115.32 | 115.33 |
| 00H | 115.33 | 115.34 | 115.35 | 115.36 | 115.37 | 115.38 | 115.39 | 115.40 |
| 00G | 115.40 | 115.41 | 115.42 | 115.43 | 115.44 | 115.45 | 115.46 | 115.47 |
| 00F | 115.47 | 115.48 | 115.49 | 115.50 | 115.51 | 115.52 | 115.53 | 115.54 |
| 00E | 115.54 | 115.55 | 115.56 | 115.57 | 115.58 | 115.59 | 115.60 | 115.61 |
| 00D | 115.61 | 115.62 | 115.63 | 115.64 | 115.65 | 115.66 | 115.67 | 115.68 |
| 00C | 115.68 | 115.69 | 115.70 | 115.71 | 115.72 | 115.73 | 115.74 | 115.75 |
| 00B | 115.75 | 115.76 | 115.77 | 115.78 | 115.79 | 115.80 | 115.81 | 115.82 |
| 00A | 115.82 | 115.83 | 115.84 | 115.85 | 115.86 | 115.87 | 115.88 | 115.89 |
| 00Z | 115.89 | 115.90 | 115.91 | 115.92 | 115.93 | 115.94 | 115.95 | 115.96 |
| 00Y | 115.96 | 115.97 | 115.98 | 115.99 | 116.00 | 116.01 | 116.02 | 116.03 |
| 00X | 116.03 | 116.04 | 116.05 | 116.06 | 116.07 | 116.08 | 116.09 | 116.10 |
| 00W | 116.10 | 116.11 | 116.12 | 116.13 | 116.14 | 116.15 | 116.16 | 116.17 |
| 00V | 116.17 | 116.18 | 116.19 | 116.20 | 116.21 | 116.22 | 116.23 | 116.24 |
| 00U | 116.24 | 116.25 | 116.26 | 116.27 | 116.28 | 116.29 | 116.30 | 116.31 |
| 00T | 116.31 | 116.32 | 116.33 | 116.34 | 116.35 | 116.36 | 116.37 | 116.38 |
| 00S | 116.38 | 116.39 | 116.40 | 116.41 | 116.42 | 116.43 | 116.44 | 116.45 |
| 00R | 116.45 | 116.46 | 116.47 | 116.48 | 116.49 | 116.50 | 116.51 | 116.52 |
| 00Q | 116.52 | 116.53 | 116.54 | 116.55 | 116.56 | 116.57 | 116.58 | 116.59 |
| 00P | 116.59 | 116.60 | 116.61 | 116.62 | 116.63 | 116.64 | 116.65 | 116.66 |
| 00O | 116.66 | 116.67 | 116.68 | 116.69 | 116.70 | 116.71 | 116.72 | 116.73 |
| 00N | 116.73 | 116.74 | 116.75 | 116.76 | 116.77 | 116.78 | 116.79 | 116.80 |
| 00M | 116.80 | 116.81 | 116.82 | 116.83 | 116.84 | 116.85 | 116.86 | 116.87 |
| 00L | 116.87 | 116.88 | 116.89 | 116.90 | 116.91 | 116.92 | 116.93 | 116.94 |
| 00K | 116.94 | 116.95 | 116.96 | 116.97 | 116.98 | 116.99 | 117.00 | 117.01 |
| 00J | 117.01 | 117.02 | 117.03 | 117.04 | 117.05 | 117.06 | 117.07 | 117.08 |
| 00I | 117.08 | 117.09 | 117.10 | 117.11 | 117.12 | 117.13 | 117.14 | 117.15 |
| 00H | 117.15 | 117.16 | 117.17 | 117.18 | 117.19 | 117.20 | 117.21 | 117.22 |
| 00G | 117.22 | 117.23 | 117.24 | 117.25 | 117.26 | 117.27 | 117.28 | 117.29 |
| 00F | 117.29 | 117.30 | 117.31 | 117.32 | 117.33 | 117.34 | 117.35 | 117.36 |
| 00E | 117.36 | 117.37 | 117.38 | 117.39 | 117.40 | 117.41 | 117.42 | 117.43 |
| 00D | 117.43 | 117.44 | 117.45 | 117.46 | 117.47 | 117.48 | 117.49 | 117.50 |
| 00C | 117.50 | 117.51 | 117.52 | 117.53 | 117.54 | 117.55 | 117.56 | 117.57 |
| 00B | 117.57 | 117.58 | 117.59 | 117.60 | 117.61 | 117.62 | 117.63 | 117.64 |
| 00A | 117.64 | 117.65 | 117.66 | 117.67 | 117.68 | 117.69 | 117.70 | 117.71 |
| 00Z | 117.71 | 117.72 | 117.73 | 117.7  |        |        |        |        |

AD-A060 062

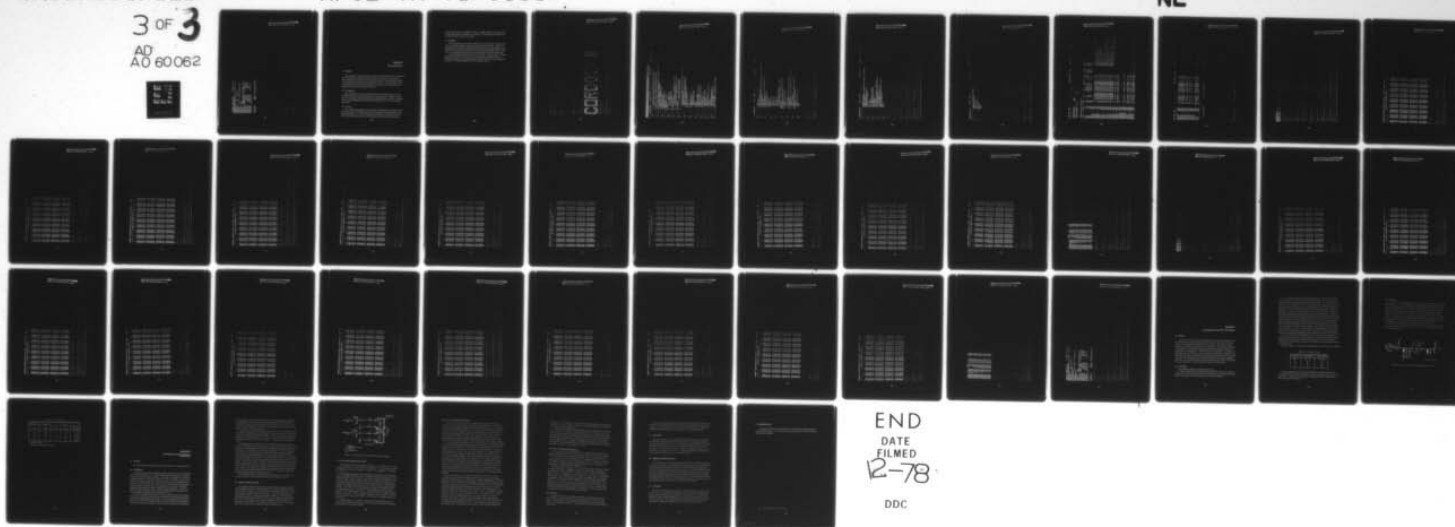
AIR FORCE GEOPHYSICS LAB HANSCOM AFB MASS  
ABOUT THE DEVELOPMENT OF A SECOND GENERATION ATMOSPHERIC SAMPLE--ETC(U)  
MAR 78 R H CORDELLA  
AFGL-TR-78-0065

F/G 4/1

UNCLASSIFIED

NL

3 OF 3  
AD  
A0 60062



THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

```

03/11/77 SCOPE 3.4.4 * CDC466A A.F.G.L.
08.59.56.COR03C FROM MEA
08.59.56.1P 0000096 WORDS - FILE INPUT , DC LE
08.59.56.COR0. 2836 CORDELLA
08.59.56.
08.59.57.FTN.SL.
09.00.03. .692 CP SECONDS COMPIATION TIME
09.00.31.LCO.
09.00.43. STOP
09.00.43. 1.839 CP SECONDS EXECUTION TIME
09.00.43.CP 0000000 WORDS - FILE OUTPUT , DC LE
09.00.43.WS 10752 WORDS ( 1.336 MAX USED)
09.00.43.CPA 3.155 SEC. .064 COST
09.00.43.IC 1.527 SEC. .010 COST
09.00.43.CW 66.093 KWS. .072 COST
09.00.43.CS COST OF JOB .147
09.00.43.CP 40.599 SEC.
09.00.43.EJ END OF JOB, **
                                DATE 03/11/77

***** COR03C //// END OF LIST ////
***** COR03C //// END OF LIST ////

```

## Appendix I

### Backup Altitude Program

#### II. GENERAL

This program is written to produce a code vs altitude dictionary for a Rosemount type altitude sensor calibrated through a voltage to frequency (V-F) converter. This combination will be used as a set with any encoder; the serial number position on the dictionary contains the serial number of each unit. Usually this data covers an envelope about the projected float altitude or about several float altitudes, depending upon the pressure range of the sensor.

##### II.1 The Algorithm

Rosemount type sensors are non-linear with respect to pressure so it is not possible to fit them to a simple exponential as the B-60 was fit. Instead, the data is fit to a general  $n$ th order equation over a selectable number of points. Numerous data runs have established that a fourth order equation fit over four to six points works well.

##### II.2 The Input

The first data card contains  $n$  for the order of the equation, the interval, serial numbers and data. Remaining cards hold one data point each; period msec vs altitude in thousands of ft. Like the preceeding two programs, more than one set of data can be entered at one time. The last data card in a set is used as a flag to

inform the program if more data sets follow. Negative numbers are used as flags because they cannot be mistaken for an altitude. The program which follows was run with two sets of data as an example.

### 11.3 The Output

After the identifying cover sheet, program, and memory map; contents of data card 1 are printed plus the count of the remaining cards in that set. Next is the dictionary 52 kft to 105 kft followed by the input data and error calculations. Note that the data covered 60 kft to 100 kft for the nominal float altitudes of 70, 80, and 90 kft. The program automatically fills the pages begun to cover the input data.

A second dictionary follows; the format is similar. Data covering 60 to 100 kft produced a dictionary for 50 to 106 kft. Comparing the headings for the two dictionaries shows that two sensors (serial numbers 148 and 149) were calibrated through V-F converter (serial No. 03) on 2 November 1976.

[illegible]

*[The page contains faint, illegible markings and noise.]*

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

PAGE 2

03/11/77 13.7.35

FIN 4.3414

PROGRAM ROSE 78/78 OPT=1

```

1      PROGRAM ROSE(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
C
C      PROGRAM TO PRODUCE A ROSEMOUNT CALIBRATION DICTIONARY
C
C      C INT= INTERVAL NUMBER OF CALIBRATION POINTS) OVER WHICH 3-ST LIN. IS
C      TO BE FIT. MUST BE AN EVEN NUMBER
C      C IOROR= ORDER OF POLYNOMIAL TO BE FIT
C      C N= ALTITUDE IN THOUSANDS OF FEET
C      C P= PERIOD IN MSEC
C      C COUNTS= COUNTS= 2000/P
C      C HSTAR= BEST ESTIMATE OF .H
C      C NC= COUNTS
C      C INPUT DATA--EACH SET
C      C CARD 1
C      C      CC 1-4 INTERVAL (I4)
C      C      CC 5-8 IOROR (I4)
C      C      CC 9-16 SERIAL NUMBER
C      C      CC 17-28 DATE
C      C      C CARD 2 THRU N+1
C      C      CC 1-10 ALTITUDE IN THOUSANDS OF FEET (I10.0)
C      C      CC 11-20 PERIOD IN MSEC (F10.0)
C      C      CARDS MUST BE IN ASCENDING ORDER BY ALTITUDE
C      C      C LAST CARD
C      C      CC 1-10 IF MORE DATA SETS FOLLOW
C      C      CC -1-0 IF IT IS THE LAST DATA SET
C
COMMON INT,INT2,IOROR,N,NC,NCEND,M(21),COUNTS(2,1),HSTAR(1,1)
1,JOROR,X0,XG,C127,ML4C
DIMENSION LETR(4),P(2,1),SN(2),DATE(3),X(3)
DATA CFTTPTMS,INT,IOROR,SN,DATE
10 READ(5,20) INT,IOROR,SN,DATE
20 FORMAT(2I4,2A4,3A6)
N=N+1
25 N=N+1
READ(5,30) M(N),P(N)
30 FORMAT(2F10.0)
COUNTS(N)= 2016./P(N)
IF (INT).GE.01 GO TO 2*
MLBL=N
31 N=N+1
WRITE(6,35) IOROR
35 FORMAT(1I4, 'ORDER READ AS',I4)
WRITE(6,40) INT
40 FORMAT(1I4, 'INTERVAL READ AS',I5)
WRITE(6,45) N
45 FORMAT(1I4, 'N IS',I4)
INT= (INT/2)*2
INT2= (INT/2)*2
IF (INT-INT2).NE.0 INT=INT2+2
INT2= INT/2
WRITE(6,50) INT
50 FORMAT(1I4, 'INTERVAL USED IS',I5)
J= INT2
CALL COEF(J)
NC=1-INT2
NC=1-INT2
NC= IFIX(COUNTS(1)/256.0)*256
DO 60 I= 1,INT2
60 CALL CMPS(HSTAR(I),COUNTS(I)*X0+XG,C,JOROR)

```

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

```

PROGRAM ROSF      74/74  OPT=1      FTN 45410
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
2205
2206
2207
2208
2209
2210
2211
2212
2213
2214
2215
2216
2217
2218
2219
2220
2221
2222
2223
2224
2225
2226
2227
2228
2229
2230
2231
2232
2233
2234
2235
2236
2237
2238
2239
2240
2241
2242
2243
2244
2245
2246
2247
2248
2249
2250
2251
2252
2253
2254
2255
2256
2257
2258
2259
2260
2261
2262
2263
2264
2265
2266
2267
2268
2269
2270
2271
2272
2273
2274
2275
2276
2277
2278
2279
2280
2281
2282
2283
2284
2285
2286
2287
2288
2289
2290
2291
2292
2293
2294
2295
2296
2297
2298
2299
2300
2301
2302
2303
2304
2305
2306
2307
2308
2309
2310
2311
2312
2313
2314
2315
2316
2317
2318
2319
2320
2321
2322
2323
2324
2325
2326
2327
2328
2329
2330
2331
2332
2333
2334
2335
2336
2337
2338
2339
2340
2341
2342
2343
2344
2345
2346
2347
2348
2349
2350
2351
2352
2353
2354
2355
2356
2357
2358
2359
2360
2361
2362
2363
2364
2365
2366
2367
2368
2369
2370
2371
2372
2373
2374
2375
2376
2377
2378
2379
2380
2381
2382
2383
2384
2385
2386
2387
2388
2389
2390
2391
2392
2393
2394
2395
2396
2397
2398
2399
2400
2401
2402
2403
2404
2405
2406
2407
2408
2409
2410
2411
2412
2413
2414
2415
2416
2417
2418
2419
2420
2421
2422
2423
2424
2425
2426
2427
2428
2429
2430
2431
2432
2433
2434
2435
2436
2437
2438
2439
2440
2441
2442
2443
2444
2445
2446
2447
2448
2449
2450
2451
2452
2453
2454
2455
2456
2457
2458
2459
2460
2461
2462
2463
2464
2465
2466
2467
2468
2469
2470
2471
2472
2473
2474
2475
2476
2477
2478
2479
2480
2481
2482
2483
2484
2485
2486
2487
2488
2489
2490
2491
2492
2493
2494
2495
2496
2497
2498
2499
2500
2501
2502
2503
2504
2505
2506
2507
2508
2509
2510
2511
2512
2513
2514
2515
2516
2517
2518
2519
2520
2521
2522
2523
2524
2525
2526
2527
2528
2529
2530
2531
2532
2533
2534
2535
2536
2537
2538
2539
2540
2541
2542
2543
2544
2545
2546
2547
2548
2549
2550
2551
2552
2553
2554
2555
2556
2557
2558
2559
2560
2561
2562
2563
2564
2565
2566
2567
2568
2569
2570
2571
2572
2573
2574
2575
2576
2577
2578
2579
2580
2581
2582
2583
2584
2585
2586
2587
2588
2589
2590
2591
2592
2593
2594
2595
2596
2597
2598
2599
2600
2601
2602
2603
2604
2605
2606
2607
2608
2609
2610
2611
2612
2613
2614
2615
2616
2617
2618
2619
2620
2621
2622
2623
2624
2625
2626
2627
2628
2629
2630
2631
2632
2633
2634
2635
2636
2637
2638
2639
2640
2641
2642
2643
2644
2645
2646
2647
2648
2649
2650
2651
2652
2653
2654
2655
2656
2657
2658
2659
2660
2661
2662
2663
2664
2665
2666
2667
2668
2669
2670
2671
2672
2673
2674
2675
2676
2677
2678
2679
2680
2681
2682
2683
2684
2685
2686
2687
2688
2689
2690
2691
2692
2693
2694
2695
2696
2697
2698
2699
2700
2701
2702
2703
2704
2705
2706
2707
2708
2709
2710
2711
2712
2713
2714
2715
2716
2717
2718
2719
2720
2721
2722
2723
2724
2725
2726
2727
2728
2729
2730
2731
2732
2733
2734
2735
2736
2737
2738
2739
2740
2741
2742
2743
2744
2745
2746
2747
2748
2749
2750
2751
2752
2753
2754
2755
2756
2757
2758
2759
2760
2761
2762
2763
2764
2765
2766
2767
2768
2769
2770
2771
2772
2773
2774
2775
2776
2777
2778
2779
2780
2781
2782
2783
2784
2785
2786
2787
2788
2789
2790
2791
2792
2793
2794
2795
2796
2797
2798
2799
2800
2801
2802
2803
2804
2805
2806
2807
2808
2809
2810
2811
2812
2813
2814
2815
2816
2817
2818
2819
2820
2821
2822
2823
2824
2825
2826
2827
2828
2829
2830
2831
2832
2833
2834
2835
2836
2837
2838
2839
2840
2841
2842
2843
2844
2845
2846
2847
2848
2849
2850
2851
2852
2853
2854
2855
2856
2857
2858
2859
2860
2861
2862
2863
2864
2865
2866
2867
2868
2869
2870
2871
2872
2873
2874
2875
2876
2877
2878
2879
2880
2881
2882
2883
2884
2885
2886
2887
2888
2889
2890
2891
2892
2893
2894
2895
2896
2897
2898
2899
2900
2901
2902
2903
2904
2905
2906
2907
2908
2909
2910
2911
2912
2913
2914
2915
2916
2917
2918
2919
2920
2921
2922
2923
2924
2925
2926
2927
2928
2929
2930
2931
2932
2933
2934
2935
2936
2937
2938
2939
2940
2941
2942
2943
2944
2945
2946
2947
2948
2949
2950
2951
2952
2953
2954
2955
2956
2957
2958
2959
2960
2961
2962
2963
2964
2965
2966
2967
2968
2969
2970
2971
2972
2973
2974
2975
2976
2977
2978
2979
2980
2981
2982
2983
2984
2985
2986
2987
2988
2989
2990
2991
2992
2993
2994
2995
2996
2997
2998
2999
3000
3001
3002
3003
3004
3005
3006
3007
3008
3009
3010
3011
3012
3013
3014
3015
3016
3017
3018
3019
3020
3021
3022
3023
3024
3025
3026
3027
3028
3029
3030
3031
3032
3033
3034
3035
3036
3037
3038
3039
3040
3041
3042
3043
3044
3045
3046
3047
3048
3049
3050
3051
3052
3053
3054
3055
3056
3057
3058
3059
3060
3061
3062
3063
3064
3065
3066
3067
3068
3069
3070
3071
3072
3073
3074
3075
3076
3077
3078
3079
3080
3081
3082
3083
3084
3085
3086
3087
3088
3089
3090
3091
3092
3093
3094
3095
3096
3097
3098
3099
3100
3101
3102
3103
3104
3105
3106
3107
3108
3109
3110
3111
3112
3113
3114
3115
3116
3117
3118
3119
3120
3121
3122
3123
3124
3125
3126
3127
3128
3129
3130
3131
3132
3133
3134
3135
3136
3137
3138
3139
3140
3141
3142
3143
3144
3145
3146
3147
3148
3149
3150
3151
3152
3153
3154
3155
3156
3157
3158
3159
3160
3161
3162
3163
3164
3165
3166
3167
3168
3169
3170
3171
3172
3173
3174
3175
3176
3177
3178
3179
3180
3181
3182
3183
3184
3185
3186
3187
3188
3189
3190
3191
3192
3193
3194
3195
3196
3197
3198
3199
3200
3201
3202
3203
3204
3205
3206
3207
3208
3209
3210
3211
3212
3213
3214
3215
3216
3217
3218
3219
3220
3221
3222
3223
3224
3225
3226
3227
3228
3229
3230
3231
3232
3233
3234
3235
3236
3237
3238
3239
3240
3241
3242
3243
3244
3245
3246
3247
3248
3249
3250
3251
3252
3253
3254
3255
3256
3257
3258
3259
3260
3261
3262
3263
3264
3265
3266
3267
3268
3269
3270
3271
3272
3273
3274
3275
3276
3277
3278
3279
3280
3281
3282
3283
3284
3285
3286
3287
3288
3289
3290
3291
3292
3293
3294
3295
3296
3297
3298
3299
3300
3301
3302
3303
3304
3305
3306
3307
3308
3309
3310
3311
3312
3313
3314
3315
3316
3317
3318
3319
3320
3321
3322
3323
3324
3325
3326
3327
3328
3329
3330
3331
3332
3333
3334
3335
3336
3337
3338
3339
3340
3341
3342
3343
3344
3345
3346
3347
3348
3349
3350
3351
3352
3353
3354
3355
3356
3357
3358
3359
3360
3361
3362
3363
3364
3365
3366
3367
3368
3369
3370
3371
3372
3373
3374
3375
3376
3377
3378
3379
3380
3381
3382
3383
3384
3385
3386
3387
3388
3389
3390
3391
3392
3393
3394
3395
3396
3397
3398
3399
3400
3401
3402
3403
3404
3405
3406
3407
3408
3409
3410
3411
3412
3413
3414
3415
3416
3417
3418
3419
3420
3421
3422
3423
3424
3425
3426
3427
3428
3429
3430
3431
3432
3433
3434
3435
3436
3437
3438
3439
3440
3441
3442
3443
3444
3445
3446
3447
3448
3449
3450
3451
3452
3453
345
```

```

1  SUBROUTINE COEF(J)
COMMON INT,INT2,JORDP,N,NC,NCEWD,M(2:1),COUNT3(2:1),HSTAP(2:1)
1,JORDR,XD,XG,C(20)
5  DIMENSION DATI(500),MOPKT(2*J)
IF(J*INT2.GT.N) RETURN
J= J*J
K1= J-INT2
K2= J*INT2-1
CALL RMVDE(COUNTS,K1,K2,DATI,1)
CALL RMVDETH,K1,K2,DATI,INT*1)
DATI(2*INT+1)= -1
JORDP= JORDP
CALL APCH(DATI,INT,JORDP,XD,XG,MOPK,IER)
CALL RPSSTWOK,JORDP,IRESS,0,5001,0.6C*1,I*P)
15 I= JORDP*(JORDP-1)/2+1
CALL RMVDE (MOPK,I,I,JORDP-I,C,I)
CALL CMPS(HSTAP(J),COUNTS(J)*XD*XG,C,JORDR)
NCFWD= I*FIX(COUNTS(J))
RETURN
END
20

```

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

1  
145

1/21/77 11:11:35

FTN 4.4414

OPT=1

74/74

SUBROUTINE RMOVE

```

1      SUBROUTINE RMOVE(X,N1,N2,Y,M1)
        DIMENSION X(1),Y(1)
        L1= M1
        DO 5 I= N1,N2
            Y(L1)= X(I)
            5 L1= L1+1
        RETURN
        END

```

## PROGRAM AND BLOCK ASSIGNMENTS.

208

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

046

01/11/77

CYBER LOADER 1 1-42

LCRD MAP - CNPS

|           |       |      |            |                  |   |       |
|-----------|-------|------|------------|------------------|---|-------|
| /SKFL.FO/ | 16456 | 7    | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| /SKFL.SQ  | 16465 | 47   | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| ERR.RM    | 16534 | 404  | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| CHMR.SQ   | 17118 | 7    | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| OSUP.RM   | 17147 | 65   | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| OPEN.SQ   | 17234 | 262  | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| CPEV.SQ   | 17516 | 14   | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| /PUT.RT/  | 17532 | 11   |            |                  |   |       |
| RLED.RM   | 17543 | 42   | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| CLSF.SQ   | 17605 | 182  | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| /CLSV.FO/ | 17737 | 7    |            |                  |   |       |
| CLSV.SQ   | 17746 | 123  | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| /REM.FO/  | 20071 | 7    |            |                  |   |       |
| REM.SQ    | 20100 | 31   | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| /GET.FO/  | 20131 | 7    |            |                  |   |       |
| /GET.RT/  | 20149 | 11   |            |                  |   |       |
| GET.SQ    | 20151 | 1035 | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| 7.ST      | 21206 | 181  | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| FSUL.SQ   | 21307 | 186  | SL-SYSTIO  | 05/28/76 COMPASS | 3 | 75125 |
| SYS.RM    | 21415 | 57   | SL-NUCLEUS | 05/28/76 COMPASS | 3 | 75125 |
| //        | 21454 | 1170 |            |                  |   |       |

PROCESS BY T.M. 1001-1

•546 CP SECONDS

341009 CM STORAGE USED

11 Table 10V 5

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ORDER READ AS  
INTERVAL READ AS  
INTERVAL USED IS

ROSEMOUNT CALIBRATION RESULTS SYN 148-03 DATE 02 NOV 76 PAGE 1

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | P     | W     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| SSS | 52.19 | 53.01 | 53.79 | 54.53 | 55.24 | 55.92 | 56.56 | 57.16 |
| SSU | 57.74 | 58.26 | 58.80 | 59.28 | 59.74 | 60.17 | 60.58 | 60.96 |
| SSK | 61.31 | 61.84 | 62.36 | 62.85 | 63.31 | 63.77 | 64.20 | 64.59 |
| SSW | 63.41 | 63.80 | 64.25 | 64.68 | 65.18 | 65.65 | 66.10 | 66.54 |
| SSD | 64.69 | 65.03 | 65.35 | 65.67 | 65.98 | 66.28 | 66.56 | 66.84 |
| SSK | 65.55 | 65.83 | 66.10 | 66.36 | 66.61 | 66.86 | 67.10 | 67.34 |
| SSG | 65.98 | 66.21 | 66.43 | 66.65 | 66.86 | 67.07 | 67.27 | 67.47 |
| SSO | 66.54 | 66.71 | 66.88 | 67.05 | 67.21 | 67.37 | 67.52 | 67.67 |
| SUS | 67.07 | 67.13 | 67.19 | 67.25 | 67.31 | 67.37 | 67.43 | 67.48 |
| SUD | 67.53 | 67.59 | 67.64 | 67.69 | 67.74 | 67.79 | 67.84 | 67.89 |
| SUR | 67.93 | 67.97 | 68.02 | 68.06 | 68.10 | 68.14 | 68.18 | 68.22 |
| SUW | 68.26 | 68.29 | 68.33 | 68.36 | 68.40 | 68.43 | 68.46 | 68.49 |
| SUD | 68.52 | 68.55 | 68.58 | 68.61 | 68.63 | 68.66 | 68.68 | 68.71 |
| SUK | 68.73 | 68.75 | 68.77 | 68.79 | 68.81 | 68.83 | 68.84 | 68.86 |
| SUG | 68.88 | 68.89 | 68.91 | 68.92 | 68.93 | 68.94 | 68.95 | 68.96 |
| SUO | 68.97 | 68.98 | 68.99 | 69.00 | 69.00 | 69.01 | 69.01 | 69.02 |
| SRS | 69.02 | 69.02 | 69.02 | 69.02 | 69.02 | 69.02 | 69.02 | 69.02 |
| SRU | 69.02 | 69.01 | 69.01 | 69.01 | 69.01 | 68.99 | 68.99 | 68.99 |
| SRP | 68.97 | 68.96 | 68.95 | 68.95 | 68.93 | 68.92 | 68.91 | 68.91 |
| SRW | 68.89 | 68.87 | 68.86 | 68.84 | 68.83 | 68.81 | 68.80 | 68.78 |
| SRO | 68.76 | 68.75 | 68.73 | 68.71 | 68.69 | 68.67 | 68.65 | 68.63 |
| SRK | 68.61 | 68.58 | 68.55 | 68.54 | 68.52 | 68.49 | 68.47 | 68.45 |
| SRG | 68.42 | 68.39 | 68.37 | 68.34 | 68.31 | 68.28 | 68.26 | 68.23 |
| SRO | 68.20 | 68.17 | 68.14 | 68.11 | 68.08 | 68.05 | 68.02 | 68.00 |
| SMS | 68.01 | 68.02 | 68.04 | 68.05 | 68.06 | 68.07 | 68.08 | 68.09 |
| SNU | 68.10 | 68.11 | 68.12 | 68.13 | 68.14 | 68.15 | 68.16 | 68.17 |
| SNP | 68.18 | 68.19 | 68.20 | 68.21 | 68.22 | 68.23 | 68.24 | 68.25 |
| SNW | 68.26 | 68.27 | 68.28 | 68.29 | 68.30 | 68.31 | 68.32 | 68.33 |
| SND | 68.33 | 68.34 | 68.35 | 68.36 | 68.37 | 68.38 | 68.39 | 68.40 |
| SNK | 68.41 | 68.42 | 68.43 | 68.44 | 68.45 | 68.46 | 68.47 | 68.48 |
| SNL | 68.49 | 68.49 | 68.51 | 68.51 | 68.51 | 68.52 | 68.53 | 68.54 |
| SNO | 68.55 | 68.56 | 68.57 | 68.57 | 68.58 | 68.59 | 68.60 | 68.61 |

ROSCOUNT CALIBRATION RESULTS SYN 148-03 DATE 02 NOV 76 PAGE 2

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | R     | W     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| SOS | 58.52 | 58.63 | 58.63 | 58.54 | 58.55 | 58.65 | 58.57 | 58.57 |
| SOU | 58.64 | 58.69 | 58.70 | 58.71 | 58.71 | 58.72 | 58.73 | 58.73 |
| SOR | 58.75 | 58.75 | 58.76 | 58.77 | 58.78 | 58.78 | 58.79 | 58.79 |
| SOW | 58.81 | 58.81 | 58.82 | 58.83 | 58.84 | 58.84 | 58.85 | 58.85 |
| SOD | 58.87 | 58.87 | 58.88 | 58.89 | 58.90 | 58.90 | 58.91 | 58.92 |
| SOK | 58.93 | 58.93 | 58.94 | 58.95 | 58.95 | 58.96 | 58.97 | 58.97 |
| SOS | 58.98 | 58.99 | 59.00 | 59.01 | 59.01 | 59.02 | 59.02 | 59.02 |
| SOD | 59.04 | 59.04 | 59.05 | 59.06 | 59.06 | 59.07 | 59.08 | 59.08 |
| SOS | 59.09 | 59.10 | 59.10 | 59.11 | 59.12 | 59.12 | 59.13 | 59.13 |
| SOU | 59.14 | 59.15 | 59.15 | 59.16 | 59.17 | 59.17 | 59.18 | 59.18 |
| SOR | 59.19 | 59.20 | 59.21 | 59.21 | 59.22 | 59.22 | 59.23 | 59.23 |
| SOW | 59.24 | 59.25 | 59.25 | 59.26 | 59.27 | 59.27 | 59.28 | 59.28 |
| SOD | 59.29 | 59.30 | 59.31 | 59.31 | 59.32 | 59.32 | 59.33 | 59.33 |
| SOK | 59.34 | 59.34 | 59.35 | 59.36 | 59.36 | 59.37 | 59.37 | 59.38 |
| SOS | 59.38 | 59.39 | 59.40 | 59.41 | 59.41 | 59.42 | 59.42 | 59.42 |
| SOD | 59.43 | 59.43 | 59.44 | 59.45 | 59.45 | 59.46 | 59.46 | 59.47 |
| SOS | 59.47 | 59.48 | 59.48 | 59.49 | 59.50 | 59.50 | 59.51 | 59.51 |
| SOU | 59.52 | 59.52 | 59.53 | 59.53 | 59.54 | 59.54 | 59.55 | 59.55 |
| SOR | 59.56 | 59.57 | 59.57 | 59.58 | 59.58 | 59.59 | 59.59 | 59.59 |
| SOW | 59.60 | 59.61 | 59.61 | 59.62 | 59.62 | 59.63 | 59.63 | 59.63 |
| SOD | 59.64 | 59.65 | 59.65 | 59.66 | 59.66 | 59.67 | 59.67 | 59.68 |
| SOK | 59.68 | 59.69 | 59.70 | 59.71 | 59.71 | 59.72 | 59.72 | 59.72 |
| SOS | 59.73 | 59.73 | 59.74 | 59.74 | 59.75 | 59.75 | 59.76 | 59.76 |
| SOD | 59.77 | 59.77 | 59.78 | 59.78 | 59.79 | 59.79 | 59.80 | 59.80 |
| SOS | 59.81 | 59.81 | 59.82 | 59.82 | 59.83 | 59.83 | 59.84 | 59.84 |
| SOU | 59.85 | 59.85 | 59.86 | 59.86 | 59.87 | 59.87 | 59.88 | 59.88 |
| SOR | 59.89 | 59.89 | 59.90 | 59.91 | 59.91 | 59.91 | 59.92 | 59.92 |
| SOW | 59.93 | 59.93 | 59.94 | 59.94 | 59.95 | 59.95 | 59.96 | 59.96 |
| SOD | 59.97 | 59.97 | 59.98 | 59.98 | 59.99 | 59.99 | 59.99 | 59.99 |
| SOK | 60.01 | 60.01 | 60.02 | 60.03 | 60.04 | 60.04 | 60.05 | 60.05 |
| SOS | 60.06 | 60.07 | 60.08 | 60.08 | 60.09 | 60.10 | 60.11 | 60.11 |
| SOD | 60.12 | 60.13 | 60.13 | 60.14 | 60.15 | 60.15 | 60.16 | 60.17 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS S/M 148-03 DATE 02 NOV 76 OAD: 3

| ALTITUDE IN THOUSANDS OF FEET |       |       |       |       |       |       |       |  |  |  |
|-------------------------------|-------|-------|-------|-------|-------|-------|-------|--|--|--|
| S                             | U     | R     | M     | U     | K     | G     | O     |  |  |  |
| USS                           | 70.18 | 70.19 | 70.20 | 70.20 | 70.21 | 70.22 | 70.22 |  |  |  |
| USU                           | 70.23 | 70.24 | 70.25 | 70.26 | 70.27 | 70.27 | 70.28 |  |  |  |
| USK                           | 70.29 | 70.30 | 70.31 | 70.32 | 70.32 | 70.33 | 70.34 |  |  |  |
| USM                           | 70.34 | 70.35 | 70.36 | 70.37 | 70.38 | 70.39 | 70.39 |  |  |  |
| USO                           | 70.40 | 70.41 | 70.42 | 70.43 | 70.44 | 70.44 | 70.45 |  |  |  |
| USK                           | 70.46 | 70.47 | 70.48 | 70.49 | 70.50 | 70.51 | 70.51 |  |  |  |
| USG                           | 70.51 | 70.52 | 70.53 | 70.54 | 70.55 | 70.56 | 70.56 |  |  |  |
| USO                           | 70.57 | 70.58 | 70.59 | 70.60 | 70.61 | 70.61 | 70.62 |  |  |  |
| UUS                           | 70.63 | 70.64 | 70.65 | 70.66 | 70.67 | 70.67 | 70.68 |  |  |  |
| UUR                           | 70.68 | 70.69 | 70.70 | 70.71 | 70.72 | 70.73 | 70.73 |  |  |  |
| UUR                           | 70.74 | 70.75 | 70.76 | 70.77 | 70.78 | 70.79 | 70.79 |  |  |  |
| UUR                           | 70.80 | 70.81 | 70.82 | 70.83 | 70.84 | 70.84 | 70.85 |  |  |  |
| UUR                           | 70.86 | 70.87 | 70.88 | 70.89 | 70.90 | 70.91 | 70.91 |  |  |  |
| UUR                           | 70.92 | 70.93 | 70.94 | 70.95 | 70.96 | 70.97 | 70.97 |  |  |  |
| UUR                           | 70.98 | 70.99 | 71.00 | 71.01 | 71.02 | 71.03 | 71.03 |  |  |  |
| UUR                           | 71.04 | 71.05 | 71.06 | 71.07 | 71.08 | 71.09 | 71.09 |  |  |  |
| URS                           | 71.10 | 71.11 | 71.12 | 71.13 | 71.13 | 71.14 | 71.14 |  |  |  |
| URU                           | 71.15 | 71.16 | 71.17 | 71.18 | 71.19 | 71.20 | 71.20 |  |  |  |
| URK                           | 71.21 | 71.22 | 71.23 | 71.24 | 71.25 | 71.26 | 71.26 |  |  |  |
| URM                           | 71.27 | 71.28 | 71.29 | 71.30 | 71.31 | 71.32 | 71.32 |  |  |  |
| URK                           | 71.33 | 71.34 | 71.35 | 71.36 | 71.37 | 71.38 | 71.38 |  |  |  |
| URK                           | 71.39 | 71.40 | 71.41 | 71.42 | 71.43 | 71.44 | 71.44 |  |  |  |
| URK                           | 71.45 | 71.46 | 71.47 | 71.48 | 71.49 | 71.50 | 71.50 |  |  |  |
| URK                           | 71.51 | 71.52 | 71.53 | 71.54 | 71.55 | 71.56 | 71.56 |  |  |  |
| URS                           | 71.57 | 71.58 | 71.59 | 71.60 | 71.61 | 71.62 | 71.62 |  |  |  |
| URU                           | 71.63 | 71.64 | 71.65 | 71.66 | 71.67 | 71.68 | 71.68 |  |  |  |
| URK                           | 71.69 | 71.70 | 71.71 | 71.72 | 71.73 | 71.74 | 71.74 |  |  |  |
| URM                           | 71.75 | 71.76 | 71.77 | 71.78 | 71.79 | 71.80 | 71.80 |  |  |  |
| URK                           | 71.81 | 71.82 | 71.83 | 71.84 | 71.85 | 71.86 | 71.86 |  |  |  |
| URK                           | 71.87 | 71.88 | 71.89 | 71.90 | 71.91 | 71.92 | 71.92 |  |  |  |
| URK                           | 71.93 | 71.94 | 71.95 | 71.96 | 71.97 | 71.98 | 71.98 |  |  |  |
| URK                           | 71.99 | 72.00 | 72.01 | 72.02 | 72.03 | 72.04 | 72.05 |  |  |  |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS S/N 148-03 DATE 12 NOV 76 PAGE 4

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | R     | W     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| UOS | 72.05 | 72.06 | 72.07 | 72.08 | 72.09 | 72.09 | 72.10 | 72.11 |
| UOU | 72.12 | 72.13 | 72.14 | 72.15 | 72.16 | 72.16 | 72.17 | 72.17 |
| UOR | 72.18 | 72.19 | 72.20 | 72.21 | 72.22 | 72.23 | 72.23 | 72.24 |
| UOW | 72.24 | 72.25 | 72.26 | 72.27 | 72.28 | 72.29 | 72.30 | 72.31 |
| UOD | 72.31 | 72.32 | 72.33 | 72.34 | 72.35 | 72.35 | 72.36 | 72.36 |
| UOK | 72.37 | 72.38 | 72.39 | 72.40 | 72.41 | 72.42 | 72.43 | 72.43 |
| UOG | 72.43 | 72.44 | 72.45 | 72.46 | 72.47 | 72.48 | 72.49 | 72.49 |
| UOO | 72.50 | 72.51 | 72.52 | 72.53 | 72.54 | 72.55 | 72.55 | 72.55 |
| UKS | 72.56 | 72.57 | 72.58 | 72.59 | 72.60 | 72.61 | 72.62 | 72.62 |
| UKU | 72.63 | 72.64 | 72.65 | 72.66 | 72.67 | 72.68 | 72.69 | 72.69 |
| UKR | 72.69 | 72.70 | 72.71 | 72.72 | 72.73 | 72.74 | 72.75 | 72.75 |
| UKW | 72.76 | 72.77 | 72.78 | 72.79 | 72.80 | 72.81 | 72.82 | 72.83 |
| UKD | 72.83 | 72.84 | 72.85 | 72.86 | 72.87 | 72.88 | 72.89 | 72.90 |
| UKK | 72.90 | 72.91 | 72.92 | 72.93 | 72.94 | 72.95 | 72.96 | 72.97 |
| UKG | 72.97 | 72.98 | 72.99 | 73.00 | 73.01 | 73.02 | 73.03 | 73.04 |
| UKO | 73.04 | 73.05 | 73.06 | 73.07 | 73.08 | 73.09 | 73.10 | 73.11 |
| UGS | 73.11 | 73.12 | 73.13 | 73.14 | 73.15 | 73.16 | 73.17 | 73.18 |
| UGU | 73.18 | 73.19 | 73.20 | 73.21 | 73.22 | 73.23 | 73.24 | 73.25 |
| UGR | 73.25 | 73.26 | 73.27 | 73.28 | 73.29 | 73.30 | 73.31 | 73.32 |
| UGW | 73.32 | 73.33 | 73.34 | 73.35 | 73.36 | 73.37 | 73.38 | 73.39 |
| UGD | 73.39 | 73.40 | 73.41 | 73.42 | 73.43 | 73.44 | 73.45 | 73.46 |
| UGK | 73.46 | 73.47 | 73.48 | 73.49 | 73.50 | 73.51 | 73.52 | 73.53 |
| UGG | 73.53 | 73.54 | 73.55 | 73.56 | 73.57 | 73.58 | 73.59 | 73.60 |
| UGO | 73.60 | 73.61 | 73.62 | 73.63 | 73.64 | 73.65 | 73.66 | 73.67 |
| UOS | 73.67 | 73.68 | 73.69 | 73.70 | 73.71 | 73.72 | 73.73 | 73.74 |
| UOU | 73.74 | 73.75 | 73.76 | 73.77 | 73.78 | 73.79 | 73.80 | 73.81 |
| UOR | 73.81 | 73.82 | 73.83 | 73.84 | 73.85 | 73.86 | 73.87 | 73.88 |
| UOW | 73.88 | 73.89 | 73.90 | 73.91 | 73.92 | 73.93 | 73.94 | 73.95 |
| UOD | 73.95 | 73.96 | 73.97 | 73.98 | 73.99 | 74.00 | 74.01 | 74.02 |
| UOK | 74.02 | 74.03 | 74.04 | 74.05 | 74.06 | 74.07 | 74.08 | 74.09 |
| UOG | 74.09 | 74.10 | 74.11 | 74.12 | 74.13 | 74.14 | 74.15 | 74.16 |
| UOO | 74.16 | 74.17 | 74.18 | 74.19 | 74.20 | 74.21 | 74.22 | 74.23 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS S/N 148-03 DATE 02 NOV 76 PAGE 5

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | R     | M     | U     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| RSS | 74.19 | 74.19 | 74.20 | 74.21 | 74.22 | 74.23 | 74.24 | 74.25 |
| RSU | 74.26 | 74.27 | 74.28 | 74.29 | 74.30 | 74.31 | 74.32 | 74.33 |
| RSR | 74.34 | 74.35 | 74.36 | 74.37 | 74.38 | 74.39 | 74.40 | 74.41 |
| PSM | 74.42 | 74.43 | 74.44 | 74.45 | 74.46 | 74.47 | 74.48 | 74.49 |
| PSU | 74.50 | 74.51 | 74.52 | 74.53 | 74.54 | 74.55 | 74.56 | 74.57 |
| PSR | 74.58 | 74.59 | 74.60 | 74.61 | 74.62 | 74.63 | 74.64 | 74.65 |
| PSG | 74.67 | 74.68 | 74.69 | 74.70 | 74.71 | 74.72 | 74.73 | 74.74 |
| PSO | 74.76 | 74.77 | 74.78 | 74.79 | 74.80 | 74.81 | 74.82 | 74.83 |
| RUS | 74.84 | 74.85 | 74.86 | 74.87 | 74.88 | 74.89 | 74.90 | 74.91 |
| RUR | 74.93 | 74.94 | 74.95 | 74.96 | 74.97 | 74.98 | 74.99 | 75.00 |
| RSU | 75.01 | 75.02 | 75.03 | 75.04 | 75.05 | 75.06 | 75.07 | 75.08 |
| RSR | 75.10 | 75.11 | 75.12 | 75.13 | 75.14 | 75.15 | 75.16 | 75.17 |
| PSM | 75.19 | 75.20 | 75.21 | 75.22 | 75.23 | 75.24 | 75.25 | 75.26 |
| PSU | 75.28 | 75.29 | 75.30 | 75.31 | 75.32 | 75.33 | 75.34 | 75.35 |
| PSR | 75.37 | 75.38 | 75.39 | 75.40 | 75.41 | 75.42 | 75.43 | 75.44 |
| PSG | 75.46 | 75.47 | 75.48 | 75.49 | 75.50 | 75.51 | 75.52 | 75.53 |
| PSO | 75.55 | 75.56 | 75.57 | 75.58 | 75.59 | 75.60 | 75.61 | 75.62 |
| RUS | 75.64 | 75.65 | 75.66 | 75.67 | 75.68 | 75.69 | 75.70 | 75.71 |
| RUR | 75.73 | 75.74 | 75.75 | 75.76 | 75.77 | 75.78 | 75.79 | 75.80 |
| RSU | 75.82 | 75.83 | 75.84 | 75.85 | 75.86 | 75.87 | 75.88 | 75.89 |
| RSR | 75.91 | 75.92 | 75.93 | 75.94 | 75.95 | 75.96 | 75.97 | 75.98 |
| PSM | 75.99 | 76.00 | 76.01 | 76.02 | 76.03 | 76.04 | 76.05 | 76.06 |
| PSU | 76.08 | 76.09 | 76.10 | 76.11 | 76.12 | 76.13 | 76.14 | 76.15 |
| PSR | 76.17 | 76.18 | 76.19 | 76.20 | 76.21 | 76.22 | 76.23 | 76.24 |
| PSG | 76.26 | 76.27 | 76.28 | 76.29 | 76.30 | 76.31 | 76.32 | 76.33 |
| PSO | 76.35 | 76.36 | 76.37 | 76.38 | 76.39 | 76.40 | 76.41 | 76.42 |
| RUS | 76.44 | 76.45 | 76.46 | 76.47 | 76.48 | 76.49 | 76.50 | 76.51 |
| RUR | 76.53 | 76.54 | 76.55 | 76.56 | 76.57 | 76.58 | 76.59 | 76.60 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSMOUNT CALIBRATION RESULTS S/N 148-03 DATE 12 NOV 76 PAGE 6

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | R     | M     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| RDS | 76.58 | 76.59 | 76.60 | 76.61 | 76.62 | 76.63 | 76.64 | 76.65 |
| RDU | 76.66 | 76.67 | 76.68 | 76.69 | 76.70 | 76.71 | 76.72 | 76.73 |
| RDR | 76.74 | 76.75 | 76.76 | 76.77 | 76.78 | 76.79 | 76.80 | 76.81 |
| RDM | 76.82 | 76.83 | 76.84 | 76.85 | 76.86 | 76.87 | 76.88 | 76.89 |
| RDN | 76.91 | 76.92 | 76.93 | 76.94 | 76.95 | 76.96 | 76.97 | 76.98 |
| RDK | 76.99 | 77.00 | 77.01 | 77.02 | 77.03 | 77.04 | 77.05 | 77.06 |
| RDS | 77.07 | 77.08 | 77.09 | 77.10 | 77.11 | 77.12 | 77.13 | 77.14 |
| RDU | 77.15 | 77.16 | 77.17 | 77.18 | 77.19 | 77.20 | 77.21 | 77.22 |
| RDS | 77.23 | 77.24 | 77.25 | 77.26 | 77.27 | 77.28 | 77.29 | 77.30 |
| RDU | 77.31 | 77.32 | 77.33 | 77.34 | 77.35 | 77.36 | 77.37 | 77.38 |
| RDR | 77.39 | 77.40 | 77.41 | 77.42 | 77.43 | 77.44 | 77.45 | 77.46 |
| RDM | 77.47 | 77.48 | 77.49 | 77.50 | 77.51 | 77.52 | 77.53 | 77.54 |
| RDN | 77.55 | 77.56 | 77.57 | 77.58 | 77.59 | 77.60 | 77.61 | 77.62 |
| RDK | 77.63 | 77.64 | 77.65 | 77.66 | 77.67 | 77.68 | 77.69 | 77.70 |
| RDS | 77.71 | 77.72 | 77.73 | 77.74 | 77.75 | 77.76 | 77.77 | 77.78 |
| RDU | 77.79 | 77.80 | 77.81 | 77.82 | 77.83 | 77.84 | 77.85 | 77.86 |
| RDS | 77.87 | 77.88 | 77.89 | 77.90 | 77.91 | 77.92 | 77.93 | 77.94 |
| RDU | 77.95 | 77.96 | 77.97 | 77.98 | 77.99 | 78.00 | 78.01 | 78.02 |
| RDR | 78.03 | 78.04 | 78.05 | 78.06 | 78.07 | 78.08 | 78.09 | 78.10 |
| RDM | 78.11 | 78.12 | 78.13 | 78.14 | 78.15 | 78.16 | 78.17 | 78.18 |
| RDN | 78.19 | 78.20 | 78.21 | 78.22 | 78.23 | 78.24 | 78.25 | 78.26 |
| RDK | 78.27 | 78.28 | 78.29 | 78.30 | 78.31 | 78.32 | 78.33 | 78.34 |
| RDS | 78.35 | 78.36 | 78.37 | 78.38 | 78.39 | 78.40 | 78.41 | 78.42 |
| RDU | 78.43 | 78.44 | 78.45 | 78.46 | 78.47 | 78.48 | 78.49 | 78.50 |
| RDR | 78.51 | 78.52 | 78.53 | 78.54 | 78.55 | 78.56 | 78.57 | 78.58 |
| RDM | 78.59 | 78.60 | 78.61 | 78.62 | 78.63 | 78.64 | 78.65 | 78.66 |
| RDN | 78.67 | 78.68 | 78.69 | 78.70 | 78.71 | 78.72 | 78.73 | 78.74 |
| RDK | 78.75 | 78.76 | 78.77 | 78.78 | 78.79 | 78.80 | 78.81 | 78.82 |
| RDS | 78.83 | 78.84 | 78.85 | 78.86 | 78.87 | 78.88 | 78.89 | 78.90 |
| RDU | 78.91 | 78.92 | 78.93 | 78.94 | 78.95 | 78.96 | 78.97 | 78.98 |
| RDR | 78.99 | 79.00 | 79.01 | 79.02 | 79.03 | 79.04 | 79.05 | 79.06 |
| RDM | 79.07 | 79.08 | 79.09 | 79.10 | 79.11 | 79.12 | 79.13 | 79.14 |
| RDN | 79.15 | 79.16 | 79.17 | 79.18 | 79.19 | 79.20 | 79.21 | 79.22 |
| RDK | 79.23 | 79.24 | 79.25 | 79.26 | 79.27 | 79.28 | 79.29 | 79.30 |
| RDS | 79.31 | 79.32 | 79.33 | 79.34 | 79.35 | 79.36 | 79.37 | 79.38 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS S/N 148-03 DATE 02 NOV 78 UAG 7

|     | S     | U     | P     | W     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| NSS | 79.35 | 79.36 | 79.37 | 79.38 | 79.41 | 79.41 | 79.42 | 79.43 |
| NSU | 79.44 | 79.46 | 79.47 | 79.48 | 79.49 | 79.50 | 79.52 | 79.53 |
| NSR | 79.54 | 79.55 | 79.56 | 79.58 | 79.59 | 79.61 | 79.62 | 79.63 |
| NSM | 79.64 | 79.65 | 79.66 | 79.67 | 79.69 | 79.70 | 79.71 | 79.72 |
| NSD | 79.73 | 79.75 | 79.76 | 79.77 | 79.78 | 79.79 | 79.81 | 79.82 |
| NSK | 79.83 | 79.84 | 79.86 | 79.87 | 79.88 | 79.89 | 79.91 | 79.92 |
| NSG | 79.93 | 79.94 | 79.95 | 79.97 | 79.98 | 79.99 | 80.00 | 80.01 |
| NSO | 80.03 | 80.04 | 80.05 | 80.06 | 80.07 | 80.09 | 80.10 | 80.11 |
| MUS | 80.12 | 80.13 | 80.15 | 80.16 | 80.17 | 80.18 | 80.19 | 80.20 |
| MUU | 80.22 | 80.23 | 80.24 | 80.25 | 80.27 | 80.28 | 80.29 | 80.30 |
| MUR | 80.31 | 80.33 | 80.34 | 80.35 | 80.36 | 80.37 | 80.39 | 80.40 |
| MUR | 80.41 | 80.42 | 80.44 | 80.45 | 80.46 | 80.47 | 80.49 | 80.50 |
| MUD | 80.51 | 80.52 | 80.53 | 80.54 | 80.56 | 80.57 | 80.59 | 80.60 |
| MOK | 80.61 | 80.62 | 80.63 | 80.64 | 80.65 | 80.67 | 80.69 | 80.70 |
| MUG | 80.70 | 80.72 | 80.73 | 80.74 | 80.75 | 80.77 | 80.78 | 80.79 |
| MUO | 80.80 | 80.81 | 80.83 | 80.84 | 80.85 | 80.86 | 80.88 | 80.89 |
| MRS | 80.90 | 80.91 | 80.93 | 80.94 | 80.95 | 80.96 | 80.98 | 80.99 |
| MRS | 81.00 | 81.01 | 81.03 | 81.04 | 81.05 | 81.06 | 81.08 | 81.09 |
| MRR | 81.10 | 81.11 | 81.13 | 81.14 | 81.15 | 81.16 | 81.18 | 81.19 |
| MRM | 81.20 | 81.21 | 81.23 | 81.24 | 81.25 | 81.26 | 81.28 | 81.29 |
| MRO | 81.30 | 81.32 | 81.33 | 81.34 | 81.35 | 81.36 | 81.38 | 81.39 |
| MRK | 81.40 | 81.42 | 81.43 | 81.44 | 81.45 | 81.47 | 81.49 | 81.50 |
| MKG | 81.51 | 81.52 | 81.53 | 81.55 | 81.56 | 81.57 | 81.59 | 81.60 |
| MRO | 81.61 | 81.62 | 81.64 | 81.65 | 81.66 | 81.67 | 81.69 | 81.70 |
| MMS | 81.71 | 81.73 | 81.74 | 81.75 | 81.77 | 81.78 | 81.79 | 81.81 |
| MNU | 81.82 | 81.83 | 81.84 | 81.86 | 81.87 | 81.88 | 81.90 | 81.91 |
| MNR | 81.92 | 81.94 | 81.95 | 81.96 | 81.98 | 81.99 | 82.00 | 82.02 |
| MNM | 82.03 | 82.04 | 82.05 | 82.07 | 82.08 | 82.10 | 82.11 | 82.12 |
| MND | 82.14 | 82.15 | 82.17 | 82.18 | 82.19 | 82.21 | 82.22 | 82.23 |
| MNK | 82.24 | 82.26 | 82.28 | 82.29 | 82.30 | 82.32 | 82.33 | 82.34 |
| MNG | 82.36 | 82.37 | 82.39 | 82.40 | 82.41 | 82.43 | 82.44 | 82.45 |
| MNO | 82.47 | 82.48 | 82.50 | 82.51 | 82.52 | 82.54 | 82.55 | 82.57 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDG

POSEMONT CALIBRATION RESULTS SAN 148-03 DATE 12 NOV 76 PAGE 8

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | R     | M     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| MOS | 82.58 | 82.59 | 82.61 | 82.62 | 82.64 | 82.65 | 82.66 | 82.68 |
| MOU | 82.69 | 82.71 | 82.72 | 82.73 | 82.75 | 82.76 | 82.77 | 82.79 |
| MOR | 82.80 | 82.82 | 82.83 | 82.85 | 82.86 | 82.87 | 82.89 | 82.91 |
| MOW | 82.92 | 82.93 | 82.95 | 82.96 | 82.97 | 82.99 | 83.00 | 83.02 |
| MND | 83.03 | 83.05 | 83.06 | 83.07 | 83.09 | 83.10 | 83.12 | 83.13 |
| MNK | 83.15 | 83.16 | 83.17 | 83.19 | 83.20 | 83.22 | 83.23 | 83.25 |
| MNG | 83.26 | 83.28 | 83.29 | 83.31 | 83.32 | 83.33 | 83.35 | 83.36 |
| MNO | 83.38 | 83.39 | 83.41 | 83.42 | 83.44 | 83.45 | 83.46 | 83.48 |
| MKS | 83.49 | 83.51 | 83.52 | 83.54 | 83.55 | 83.57 | 83.58 | 83.60 |
| MKU | 83.61 | 83.63 | 83.64 | 83.65 | 83.67 | 83.68 | 83.70 | 83.71 |
| MKR | 83.73 | 83.74 | 83.76 | 83.77 | 83.79 | 83.80 | 83.82 | 83.83 |
| MKW | 83.85 | 83.86 | 83.88 | 83.89 | 83.91 | 83.92 | 83.94 | 83.95 |
| MKD | 83.96 | 83.98 | 83.99 | 84.01 | 84.02 | 84.04 | 84.05 | 84.07 |
| MKG | 84.08 | 84.10 | 84.11 | 84.13 | 84.14 | 84.16 | 84.17 | 84.19 |
| MKK | 84.20 | 84.22 | 84.23 | 84.25 | 84.26 | 84.28 | 84.29 | 84.31 |
| MKO | 84.32 | 84.34 | 84.35 | 84.37 | 84.38 | 84.40 | 84.41 | 84.43 |
| MGS | 84.44 | 84.46 | 84.47 | 84.49 | 84.50 | 84.52 | 84.53 | 84.55 |
| MGU | 84.56 | 84.58 | 84.59 | 84.61 | 84.62 | 84.64 | 84.65 | 84.67 |
| MGR | 84.68 | 84.70 | 84.71 | 84.73 | 84.74 | 84.76 | 84.78 | 84.79 |
| MGM | 84.81 | 84.82 | 84.84 | 84.85 | 84.87 | 84.89 | 84.90 | 84.91 |
| MGO | 84.93 | 84.94 | 84.96 | 84.97 | 84.99 | 85.01 | 85.02 | 85.04 |
| MKG | 85.05 | 85.07 | 85.08 | 85.10 | 85.11 | 85.13 | 85.14 | 85.16 |
| MGG | 85.18 | 85.19 | 85.21 | 85.22 | 85.24 | 85.25 | 85.27 | 85.28 |
| MGO | 85.30 | 85.32 | 85.33 | 85.35 | 85.36 | 85.38 | 85.39 | 85.41 |
| MOS | 85.42 | 85.44 | 85.46 | 85.47 | 85.49 | 85.50 | 85.52 | 85.53 |
| MOU | 85.55 | 85.57 | 85.58 | 85.60 | 85.61 | 85.63 | 85.64 | 85.66 |
| MOR | 85.68 | 85.69 | 85.71 | 85.72 | 85.74 | 85.75 | 85.77 | 85.79 |
| MOW | 85.80 | 85.82 | 85.84 | 85.85 | 85.87 | 85.88 | 85.90 | 85.92 |
| MND | 85.93 | 85.95 | 85.96 | 85.98 | 86.00 | 86.01 | 86.03 | 86.04 |
| MNK | 86.06 | 86.08 | 86.09 | 86.11 | 86.13 | 86.14 | 86.16 | 86.17 |
| MNG | 86.19 | 86.21 | 86.22 | 86.24 | 86.25 | 86.27 | 86.29 | 86.30 |
| MNO | 86.32 | 86.34 | 86.35 | 86.37 | 86.38 | 86.40 | 86.42 | 86.43 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS S/N 148-03 DATE 12 NOV 76 PAGE 9

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | P     | M     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| DSS | 86.45 | 86.47 | 86.48 | 86.50 | 86.51 | 86.53 | 86.55 | 86.56 |
| DSU | 86.58 | 86.60 | 86.61 | 86.63 | 86.65 | 86.66 | 86.68 | 86.70 |
| DSR | 86.71 | 86.73 | 86.74 | 86.76 | 86.78 | 86.80 | 86.81 | 86.83 |
| DSM | 86.85 | 86.86 | 86.88 | 86.90 | 86.91 | 86.93 | 86.95 | 86.96 |
| DSO | 86.98 | 87.00 | 87.01 | 87.03 | 87.05 | 87.06 | 87.08 | 87.10 |
| DSK | 87.11 | 87.13 | 87.15 | 87.17 | 87.18 | 87.20 | 87.22 | 87.23 |
| DSG | 87.25 | 87.27 | 87.28 | 87.30 | 87.32 | 87.34 | 87.35 | 87.37 |
| DSO | 87.39 | 87.40 | 87.42 | 87.44 | 87.46 | 87.47 | 87.49 | 87.51 |
| DUS | 87.53 | 87.54 | 87.56 | 87.58 | 87.59 | 87.61 | 87.63 | 87.65 |
| DUU | 87.66 | 87.68 | 87.70 | 87.72 | 87.73 | 87.75 | 87.77 | 87.79 |
| DUR | 87.80 | 87.82 | 87.84 | 87.85 | 87.86 | 87.89 | 87.91 | 87.93 |
| DUM | 87.95 | 87.96 | 87.98 | 88.00 | 88.02 | 88.03 | 88.05 | 88.07 |
| DUD | 88.09 | 88.11 | 88.12 | 88.14 | 88.16 | 88.18 | 88.20 | 88.21 |
| DUG | 88.23 | 88.25 | 88.27 | 88.29 | 88.30 | 88.32 | 88.34 | 88.36 |
| DUG | 88.38 | 88.39 | 88.41 | 88.43 | 88.45 | 88.47 | 88.49 | 88.51 |
| DUD | 88.52 | 88.54 | 88.56 | 88.58 | 88.60 | 88.61 | 88.63 | 88.65 |
| DRS | 88.67 | 88.69 | 88.71 | 88.73 | 88.74 | 88.76 | 88.78 | 88.80 |
| DRU | 88.82 | 88.84 | 88.86 | 88.87 | 88.89 | 88.91 | 88.93 | 88.95 |
| DRR | 88.97 | 88.99 | 89.01 | 89.03 | 89.04 | 89.06 | 89.08 | 89.10 |
| DRM | 89.12 | 89.14 | 89.16 | 89.18 | 89.20 | 89.22 | 89.24 | 89.26 |
| DRO | 89.27 | 89.29 | 89.31 | 89.33 | 89.35 | 89.37 | 89.39 | 89.41 |
| CRK | 89.43 | 89.45 | 89.47 | 89.49 | 89.51 | 89.53 | 89.55 | 89.57 |
| DRG | 89.59 | 89.61 | 89.63 | 89.65 | 89.67 | 89.69 | 89.71 | 89.73 |
| DRO | 89.75 | 89.77 | 89.79 | 89.81 | 89.83 | 89.85 | 89.87 | 89.89 |
| DWS | 89.91 | 89.93 | 89.95 | 89.97 | 89.99 | 90.01 | 90.03 | 90.05 |
| DWU | 90.07 | 90.09 | 90.11 | 90.13 | 90.15 | 90.17 | 90.19 | 90.21 |
| DWR | 90.24 | 90.26 | 90.28 | 90.30 | 90.32 | 90.34 | 90.37 | 90.39 |
| DWM | 90.41 | 90.43 | 90.45 | 90.47 | 90.49 | 90.52 | 90.54 | 90.56 |
| DWD | 90.58 | 90.60 | 90.62 | 90.65 | 90.67 | 90.69 | 90.71 | 90.73 |
| DWK | 90.75 | 90.78 | 90.80 | 90.82 | 90.84 | 90.86 | 90.88 | 90.91 |
| DWG | 90.93 | 90.95 | 90.97 | 90.99 | 91.02 | 91.04 | 91.06 | 91.08 |
| DWO | 91.10 | 91.13 | 91.15 | 91.17 | 91.19 | 91.21 | 91.24 | 91.26 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS S/N 148-C3 DATE 02 NOV 76 PAGE 1

|     | ALTITUDE IN THOUSANDS OF FEET |       |       |       |       |       |       |       |  |  |
|-----|-------------------------------|-------|-------|-------|-------|-------|-------|-------|--|--|
|     | S                             | U     | R     | M     | N     | K     | G     | U     |  |  |
| DDS | 91.28                         | 91.30 | 91.32 | 91.35 | 91.37 | 91.39 | 91.41 | 91.43 |  |  |
| DDU | 91.46                         | 91.48 | 91.50 | 91.52 | 91.55 | 91.57 | 91.59 | 91.61 |  |  |
| DDR | 91.63                         | 91.66 | 91.68 | 91.70 | 91.72 | 91.74 | 91.77 | 91.79 |  |  |
| DDM | 91.81                         | 91.83 | 91.86 | 91.88 | 91.90 | 91.92 | 91.95 | 91.97 |  |  |
| DDW | 91.99                         | 92.01 | 92.03 | 92.05 | 92.07 | 92.10 | 92.12 | 92.14 |  |  |
| DDK | 92.16                         | 92.18 | 92.20 | 92.23 | 92.25 | 92.27 | 92.28 | 92.31 |  |  |
| DDG | 92.33                         | 92.35 | 92.38 | 92.40 | 92.42 | 92.44 | 92.46 | 92.48 |  |  |
| DDO | 92.50                         | 92.53 | 92.55 | 92.57 | 92.59 | 92.61 | 92.63 | 92.65 |  |  |
| DKS | 92.68                         | 92.70 | 92.72 | 92.74 | 92.76 | 92.78 | 92.81 | 92.83 |  |  |
| DKU | 92.85                         | 92.87 | 92.89 | 92.92 | 92.94 | 92.96 | 92.98 | 93.00 |  |  |
| DKR | 93.03                         | 93.05 | 93.07 | 93.09 | 93.11 | 93.14 | 93.16 | 93.18 |  |  |
| DKM | 93.20                         | 93.22 | 93.25 | 93.27 | 93.29 | 93.31 | 93.34 | 93.36 |  |  |
| DKO | 93.38                         | 93.40 | 93.42 | 93.45 | 93.47 | 93.49 | 93.51 | 93.53 |  |  |
| DKK | 93.56                         | 93.58 | 93.61 | 93.63 | 93.65 | 93.67 | 93.70 | 93.72 |  |  |
| DKG | 93.74                         | 93.76 | 93.79 | 93.81 | 93.83 | 93.85 | 93.88 | 93.90 |  |  |
| DKO | 93.93                         | 93.95 | 93.97 | 94.00 | 94.02 | 94.04 | 94.07 | 94.09 |  |  |
| DGS | 94.11                         | 94.14 | 94.16 | 94.19 | 94.21 | 94.24 | 94.26 | 94.28 |  |  |
| DGU | 94.31                         | 94.33 | 94.36 | 94.38 | 94.41 | 94.43 | 94.45 | 94.48 |  |  |
| DGR | 94.50                         | 94.53 | 94.55 | 94.58 | 94.60 | 94.63 | 94.65 | 94.68 |  |  |
| DGM | 94.70                         | 94.73 | 94.75 | 94.78 | 94.80 | 94.83 | 94.85 | 94.88 |  |  |
| DGO | 94.90                         | 94.93 | 94.95 | 94.98 | 95.00 | 95.03 | 95.05 | 95.08 |  |  |
| DGI | 95.10                         | 95.13 | 95.15 | 95.18 | 95.21 | 95.23 | 95.26 | 95.28 |  |  |
| DGK | 95.31                         | 95.34 | 95.36 | 95.39 | 95.41 | 95.44 | 95.46 | 95.49 |  |  |
| DGO | 95.52                         | 95.54 | 95.57 | 95.60 | 95.62 | 95.65 | 95.67 | 95.70 |  |  |
| DOS | 95.73                         | 95.75 | 95.78 | 95.81 | 95.83 | 95.86 | 95.89 | 95.91 |  |  |
| DOU | 95.94                         | 95.97 | 95.99 | 96.02 | 96.05 | 96.07 | 96.10 | 96.13 |  |  |
| DOR | 96.16                         | 96.18 | 96.21 | 96.24 | 96.27 | 96.29 | 96.32 | 96.35 |  |  |
| DOM | 96.38                         | 96.40 | 96.43 | 96.46 | 96.49 | 96.51 | 96.54 | 96.57 |  |  |
| DOD | 96.60                         | 96.62 | 96.65 | 96.68 | 96.71 | 96.74 | 96.76 | 96.79 |  |  |
| DOK | 96.82                         | 96.85 | 96.88 | 96.90 | 96.93 | 96.96 | 96.99 | 97.02 |  |  |
| DOK | 97.05                         | 97.07 | 97.10 | 97.13 | 97.16 | 97.19 | 97.22 | 97.24 |  |  |
| DOO | 97.27                         | 97.30 | 97.33 | 97.36 | 97.39 | 97.41 | 97.44 | 97.47 |  |  |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS SPN 148-03 DATE 12 NOV 76 PAGE 11

ALTITUDE IN THOUSANDS OF FEET

|     | S      | U      | R      | W      | E      | K      | G      | O      |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|
| KSS | 97.50  | 97.53  | 97.56  | 97.59  | 97.62  | 97.65  | 97.67  | 97.70  |
| KSU | 97.73  | 97.76  | 97.79  | 97.82  | 97.85  | 97.87  | 97.90  | 97.93  |
| KSR | 97.96  | 97.99  | 98.02  | 98.05  | 98.08  | 98.11  | 98.14  | 98.17  |
| KSM | 98.19  | 98.22  | 98.25  | 98.28  | 98.31  | 98.34  | 98.37  | 98.40  |
| KSD | 98.43  | 98.46  | 98.49  | 98.51  | 98.54  | 98.57  | 98.60  | 98.63  |
| KSK | 98.66  | 98.69  | 98.72  | 98.75  | 98.78  | 98.81  | 98.84  | 98.87  |
| KSG | 98.90  | 98.93  | 98.95  | 98.98  | 99.01  | 99.04  | 99.07  | 99.10  |
| KSO | 99.13  | 99.16  | 99.19  | 99.22  | 99.25  | 99.28  | 99.31  | 99.34  |
| KUS | 99.37  | 99.40  | 99.43  | 99.45  | 99.48  | 99.51  | 99.54  | 99.57  |
| KUU | 99.60  | 99.63  | 99.66  | 99.69  | 99.72  | 99.75  | 99.78  | 99.81  |
| KUR | 99.84  | 99.87  | 99.90  | 99.93  | 99.96  | 99.99  | 100.01 | 100.04 |
| KUR | 100.07 | 100.10 | 100.13 | 100.16 | 100.19 | 100.22 | 100.25 | 100.28 |
| KUD | 100.31 | 100.34 | 100.37 | 100.40 | 100.43 | 100.46 | 100.49 | 100.51 |
| KUG | 100.54 | 100.57 | 100.60 | 100.63 | 100.66 | 100.69 | 100.72 | 100.75 |
| KUG | 100.78 | 100.81 | 100.84 | 100.87 | 100.90 | 100.93 | 100.96 | 100.99 |
| KUU | 101.01 | 101.04 | 101.07 | 101.10 | 101.13 | 101.16 | 101.19 | 101.22 |
| KRS | 101.25 | 101.27 | 101.30 | 101.33 | 101.36 | 101.39 | 101.42 | 101.45 |
| KRU | 101.48 | 101.51 | 101.54 | 101.56 | 101.59 | 101.62 | 101.65 | 101.68 |
| KRR | 101.71 | 101.74 | 101.77 | 101.79 | 101.82 | 101.85 | 101.88 | 101.91 |
| KRM | 101.94 | 101.97 | 102.00 | 102.02 | 102.05 | 102.08 | 102.11 | 102.14 |
| KRO | 102.17 | 102.19 | 102.22 | 102.25 | 102.28 | 102.31 | 102.34 | 102.36 |
| KRK | 102.39 | 102.42 | 102.45 | 102.48 | 102.51 | 102.53 | 102.56 | 102.59 |
| KRG | 102.62 | 102.65 | 102.67 | 102.70 | 102.73 | 102.76 | 102.79 | 102.81 |
| KRO | 102.84 | 102.87 | 102.91 | 102.92 | 102.95 | 102.98 | 103.01 | 103.03 |
| KMS | 103.06 | 103.09 | 103.12 | 103.14 | 103.17 | 103.20 | 103.23 | 103.25 |
| KMU | 103.28 | 103.31 | 103.34 | 103.36 | 103.39 | 103.42 | 103.44 | 103.47 |
| KMR | 103.50 | 103.52 | 103.55 | 103.58 | 103.60 | 103.63 | 103.66 | 103.68 |
| KMW | 103.71 | 103.74 | 103.76 | 103.79 | 103.82 | 103.84 | 103.87 | 103.89 |
| KMD | 103.92 | 103.95 | 103.98 | 104.00 | 104.03 | 104.05 | 104.08 | 104.11 |
| KMK | 104.13 | 104.16 | 104.18 | 104.21 | 104.24 | 104.26 | 104.29 | 104.31 |
| KMG | 104.34 | 104.36 | 104.39 | 104.41 | 104.44 | 104.46 | 104.49 | 104.52 |
| KMO | 104.54 | 104.57 | 104.59 | 104.62 | 104.64 | 104.67 | 104.69 | 104.72 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

| M       | P       | COUNTS | M <sup>2</sup> | M-H <sup>2</sup> |
|---------|---------|--------|----------------|------------------|
| 60.000  | 158.800 | 12.6   | 63.000         | .000             |
| 62.000  | 116.200 | 19.1   | 82.000         | -.000            |
| 64.000  | 72.668  | 27.5   | 84.000         | .000             |
| 66.000  | 30.898  | 88.9   | 86.000         | .000             |
| 68.000  | 10.498  | 190.7  | 68.000         | .000             |
| 70.000  | 4.198   | 686.9  | 70.000         | .000             |
| 72.000  | 2.628   | 761.0  | 72.000         | .000             |
| 74.000  | 1.998   | 1803.8 | 74.000         | .000             |
| 76.000  | 1.648   | 1219.5 | 76.000         | .000             |
| 78.000  | 1.409   | 1419.4 | 78.000         | .000             |
| 80.000  | 1.250   | 1599.8 | 80.000         | .000             |
| 82.000  | 1.183   | 1749.8 | 82.000         | .000             |
| 84.000  | 1.050   | 1899.4 | 84.000         | .000             |
| 86.000  | .990    | 2020.2 | 86.000         | .000             |
| 88.000  | .935    | 2139.0 | 88.000         | .000             |
| 90.000  | .891    | 2248.7 | 90.000         | .000             |
| 92.000  | .856    | 2336.4 | 92.000         | .000             |
| 94.000  | .824    | 2427.2 | 94.000         | .000             |
| 96.000  | .798    | 2506.3 | 96.000         | .000             |
| 98.000  | .776    | 2577.3 | 98.000         | .000             |
| 100.000 | .756    | 2645.5 | 100.000        | .000             |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ORDER READ AS  
INTERVAL READ AS  
INTERVAL USED IS

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDG

ROSEHUNT CALIBRATION RESULTS S/N 149-03 DATE 02 NOV '66 PAGE 1

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | P     | M     | D     | K     | G     | C     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| SSS | 49.83 | 50.70 | 50.96 | 51.57 | 52.18 | 52.77 | 53.34 | 53.99 |
| SSU | 54.42 | 55.94 | 55.44 | 55.92 | 56.38 | 56.83 | 57.28 | 57.80 |
| SSR | 58.08 | 58.47 | 58.84 | 59.20 | 59.55 | 59.88 | 60.20 | 60.50 |
| SSM | 60.80 | 61.08 | 61.35 | 61.61 | 61.85 | 62.03 | 62.22 | 62.43 |
| SSD | 62.74 | 62.94 | 63.13 | 63.31 | 63.48 | 63.65 | 63.81 | 63.98 |
| SSK | 64.11 | 64.25 | 64.39 | 64.53 | 64.66 | 64.78 | 64.93 | 65.10 |
| SSG | 65.13 | 65.23 | 65.33 | 65.43 | 65.52 | 65.61 | 65.69 | 65.78 |
| SSO | 65.84 | 65.91 | 65.97 | 66.05 | 66.13 | 66.21 | 66.29 | 66.37 |
| SUS | 66.45 | 66.52 | 66.59 | 66.66 | 66.73 | 66.80 | 66.86 | 66.92 |
| SUU | 66.99 | 67.05 | 67.11 | 67.16 | 67.22 | 67.27 | 67.32 | 67.37 |
| SUR | 67.42 | 67.47 | 67.51 | 67.56 | 67.60 | 67.64 | 67.68 | 67.72 |
| SUM | 67.75 | 67.78 | 67.82 | 67.85 | 67.88 | 67.92 | 67.95 | 67.98 |
| SUD | 67.98 | 68.00 | 68.02 | 68.04 | 68.06 | 68.08 | 68.10 | 68.11 |
| SUK | 68.12 | 68.13 | 68.14 | 68.15 | 68.16 | 68.17 | 68.18 | 68.19 |
| SUG | 68.17 | 68.17 | 68.17 | 68.17 | 68.17 | 68.17 | 68.17 | 68.17 |
| SUO | 68.15 | 68.14 | 68.13 | 68.12 | 68.11 | 68.09 | 68.06 | 68.03 |
| SRS | 68.05 | 68.73 | 68.02 | 68.02 | 68.77 | 68.05 | 68.77 | 68.79 |
| SRU | 68.11 | 68.13 | 68.15 | 68.17 | 68.19 | 68.21 | 68.23 | 68.25 |
| SRM | 68.27 | 68.29 | 68.31 | 68.33 | 68.35 | 68.37 | 68.39 | 68.41 |
| SRN | 68.42 | 68.44 | 68.46 | 68.48 | 68.50 | 68.51 | 68.53 | 68.55 |
| SRD | 68.57 | 68.58 | 68.60 | 68.62 | 68.63 | 68.65 | 68.67 | 68.69 |
| SRK | 68.70 | 68.72 | 68.73 | 68.75 | 68.76 | 68.78 | 68.79 | 68.81 |
| SRG | 68.82 | 68.84 | 68.85 | 68.87 | 68.88 | 68.90 | 68.91 | 68.93 |
| SRO | 68.94 | 68.96 | 68.97 | 68.98 | 69.00 | 69.01 | 69.02 | 69.03 |
| SMS | 69.05 | 69.06 | 69.08 | 69.09 | 69.10 | 69.11 | 69.12 | 69.13 |
| SMU | 69.15 | 69.16 | 69.18 | 69.19 | 69.20 | 69.21 | 69.22 | 69.23 |
| SMR | 69.25 | 69.26 | 69.27 | 69.28 | 69.29 | 69.30 | 69.31 | 69.32 |
| SMN | 69.33 | 69.34 | 69.35 | 69.36 | 69.37 | 69.38 | 69.39 | 69.40 |
| SMD | 69.41 | 69.42 | 69.43 | 69.44 | 69.45 | 69.46 | 69.47 | 69.48 |
| SMK | 69.49 | 69.49 | 69.50 | 69.51 | 69.52 | 69.53 | 69.54 | 69.55 |
| SMG | 69.56 | 69.56 | 69.57 | 69.58 | 69.59 | 69.59 | 69.60 | 69.61 |
| SMD | 69.61 | 69.62 | 69.63 | 69.63 | 69.64 | 69.65 | 69.65 | 69.66 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS S/N 149-C3 DATE 02 NOV 76 PAGE 2

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | P     | W     | D     | K     | G     | D     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| SUS | 69.67 | 69.67 | 69.68 | 69.69 | 69.69 | 69.71 | 69.71 | 69.71 |
| SOU | 69.72 | 69.72 | 69.73 | 69.73 | 69.74 | 69.75 | 69.75 | 69.76 |
| SDR | 69.76 | 69.77 | 69.77 | 69.78 | 69.78 | 69.79 | 69.79 | 69.80 |
| SOM | 69.80 | 69.81 | 69.81 | 69.81 | 69.82 | 69.82 | 69.83 | 69.83 |
| SOD | 69.84 | 69.84 | 69.84 | 69.85 | 69.85 | 69.86 | 69.86 | 69.86 |
| SDK | 69.87 | 69.87 | 69.87 | 69.88 | 69.88 | 69.89 | 69.89 | 69.89 |
| SOG | 69.89 | 69.90 | 69.90 | 69.90 | 69.91 | 69.91 | 69.91 | 69.91 |
| S00 | 69.92 | 69.92 | 69.92 | 69.92 | 69.93 | 69.93 | 69.93 | 69.93 |
| SXS | 69.94 | 69.94 | 69.94 | 69.94 | 69.94 | 69.95 | 69.95 | 69.95 |
| SXU | 69.95 | 69.95 | 69.96 | 69.96 | 69.96 | 69.96 | 69.96 | 69.96 |
| SXR | 69.96 | 69.97 | 69.97 | 69.97 | 69.97 | 69.97 | 69.97 | 69.97 |
| SXW | 69.98 | 69.98 | 69.98 | 69.98 | 69.98 | 69.98 | 69.98 | 69.98 |
| SXD | 69.98 | 69.99 | 69.99 | 69.99 | 69.99 | 69.99 | 69.99 | 69.99 |
| SXK | 69.99 | 69.99 | 69.99 | 69.99 | 69.99 | 69.99 | 69.99 | 69.99 |
| SXG | 69.99 | 69.99 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SX0 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXS | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXU | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXR | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXW | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXD | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXK | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXG | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SX0 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXS | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXU | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXR | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXW | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXD | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXK | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SXG | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| SX0 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS S/N 149-03 DATE 02 NOV 76 PAGE 3

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | R     | N     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| USS | 70.72 | 70.73 | 70.74 | 70.75 | 70.76 | 70.77 | 70.78 | 70.79 |
| USU | 70.78 | 70.79 | 70.80 | 70.81 | 70.82 | 70.83 | 70.84 | 70.85 |
| USK | 70.86 | 70.87 | 70.88 | 70.89 | 70.90 | 70.91 | 70.92 | 70.93 |
| USM | 70.94 | 70.95 | 70.96 | 70.97 | 70.98 | 70.99 | 71.00 | 71.01 |
| USD | 71.02 | 71.03 | 71.04 | 71.05 | 71.06 | 71.07 | 71.08 | 71.09 |
| USK | 71.10 | 71.11 | 71.12 | 71.13 | 71.14 | 71.15 | 71.16 | 71.17 |
| USG | 71.18 | 71.19 | 71.20 | 71.21 | 71.22 | 71.23 | 71.24 | 71.25 |
| USU | 71.26 | 71.27 | 71.28 | 71.29 | 71.30 | 71.31 | 71.32 | 71.33 |
| USR | 71.34 | 71.35 | 71.36 | 71.37 | 71.38 | 71.39 | 71.40 | 71.41 |
| USN | 71.42 | 71.43 | 71.44 | 71.45 | 71.46 | 71.47 | 71.48 | 71.49 |
| USD | 71.50 | 71.51 | 71.52 | 71.53 | 71.54 | 71.55 | 71.56 | 71.57 |
| USK | 71.58 | 71.59 | 71.60 | 71.61 | 71.62 | 71.63 | 71.64 | 71.65 |
| USU | 71.66 | 71.67 | 71.68 | 71.69 | 71.70 | 71.71 | 71.72 | 71.73 |
| USR | 71.74 | 71.75 | 71.76 | 71.77 | 71.78 | 71.79 | 71.80 | 71.81 |
| USN | 71.82 | 71.83 | 71.84 | 71.85 | 71.86 | 71.87 | 71.88 | 71.89 |
| USD | 71.90 | 71.91 | 71.92 | 71.93 | 71.94 | 71.95 | 71.96 | 71.97 |
| USK | 71.98 | 71.99 | 72.00 | 72.01 | 72.02 | 72.03 | 72.04 | 72.05 |
| USU | 72.06 | 72.07 | 72.08 | 72.09 | 72.10 | 72.11 | 72.12 | 72.13 |
| USM | 72.14 | 72.15 | 72.16 | 72.17 | 72.18 | 72.19 | 72.20 | 72.21 |
| USU | 72.22 | 72.23 | 72.24 | 72.25 | 72.26 | 72.27 | 72.28 | 72.29 |
| USR | 72.30 | 72.31 | 72.32 | 72.33 | 72.34 | 72.35 | 72.36 | 72.37 |
| USN | 72.38 | 72.39 | 72.40 | 72.41 | 72.42 | 72.43 | 72.44 | 72.45 |
| USD | 72.46 | 72.47 | 72.48 | 72.49 | 72.50 | 72.51 | 72.52 | 72.53 |
| USK | 72.54 | 72.55 | 72.56 | 72.57 | 72.58 | 72.59 | 72.60 | 72.61 |
| USU | 72.62 | 72.63 | 72.64 | 72.65 | 72.66 | 72.67 | 72.68 | 72.69 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS SYN 149-03 DATE 12 NOV 76 PAGE 1

|     | ALTITUDE IN THOUSANDS OF FEET |       |       |       |       |       |       |       |       |  |
|-----|-------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|--|
|     | S                             | U     | R     | W     | D     | K     | G     | O     |       |  |
| UNS | 72.63                         | 72.63 | 72.64 | 72.65 | 72.66 | 72.67 | 72.67 | 72.67 | 72.68 |  |
| UDU | 72.69                         | 72.70 | 72.71 | 72.72 | 72.73 | 72.73 | 72.73 | 72.73 | 72.74 |  |
| UDR | 72.76                         | 72.76 | 72.77 | 72.78 | 72.79 | 72.80 | 72.80 | 72.80 | 72.81 |  |
| UDM | 72.82                         | 72.83 | 72.84 | 72.85 | 72.86 | 72.86 | 72.87 | 72.87 | 72.88 |  |
| UDN | 72.89                         | 72.89 | 72.90 | 72.91 | 72.92 | 72.93 | 72.93 | 72.93 | 72.94 |  |
| UDK | 72.95                         | 72.96 | 72.97 | 72.98 | 72.98 | 72.99 | 72.99 | 73.00 | 73.01 |  |
| UDG | 73.02                         | 73.02 | 73.03 | 73.04 | 73.05 | 73.06 | 73.07 | 73.07 | 73.08 |  |
| UDQ | 73.08                         | 73.09 | 73.10 | 73.11 | 73.11 | 73.12 | 73.13 | 73.13 | 73.14 |  |
| UKS | 73.15                         | 73.16 | 73.16 | 73.17 | 73.18 | 73.19 | 73.20 | 73.20 | 73.21 |  |
| UKR | 73.21                         | 73.22 | 73.23 | 73.24 | 73.25 | 73.26 | 73.26 | 73.27 | 73.28 |  |
| UKM | 73.29                         | 73.30 | 73.30 | 73.31 | 73.32 | 73.33 | 73.33 | 73.34 | 73.35 |  |
| UKN | 73.35                         | 73.36 | 73.37 | 73.38 | 73.39 | 73.40 | 73.41 | 73.42 | 73.43 |  |
| UKO | 73.44                         | 73.45 | 73.46 | 73.47 | 73.48 | 73.49 | 73.50 | 73.51 | 73.52 |  |
| UKP | 73.53                         | 73.54 | 73.55 | 73.56 | 73.57 | 73.58 | 73.59 | 73.60 | 73.61 |  |
| UKQ | 73.62                         | 73.63 | 73.64 | 73.65 | 73.66 | 73.67 | 73.68 | 73.69 | 73.70 |  |
| UGS | 73.71                         | 73.72 | 73.73 | 73.74 | 73.75 | 73.76 | 73.77 | 73.78 | 73.79 |  |
| UGU | 73.80                         | 73.81 | 73.82 | 73.83 | 73.84 | 73.85 | 73.86 | 73.87 | 73.88 |  |
| UGR | 73.89                         | 73.90 | 73.91 | 73.92 | 73.93 | 73.94 | 73.95 | 73.96 | 73.97 |  |
| UGM | 73.98                         | 73.99 | 74.00 | 74.01 | 74.02 | 74.03 | 74.04 | 74.05 | 74.06 |  |
| UGN | 74.07                         | 74.08 | 74.09 | 74.10 | 74.11 | 74.12 | 74.13 | 74.14 | 74.15 |  |
| UGO | 74.16                         | 74.17 | 74.18 | 74.19 | 74.20 | 74.21 | 74.22 | 74.23 | 74.24 |  |
| UOS | 74.25                         | 74.26 | 74.27 | 74.28 | 74.29 | 74.30 | 74.31 | 74.32 | 74.33 |  |
| UOU | 74.34                         | 74.35 | 74.36 | 74.37 | 74.38 | 74.39 | 74.40 | 74.41 | 74.42 |  |
| UOR | 74.43                         | 74.44 | 74.45 | 74.46 | 74.47 | 74.48 | 74.49 | 74.50 | 74.51 |  |
| UOW | 74.52                         | 74.53 | 74.54 | 74.55 | 74.56 | 74.57 | 74.58 | 74.59 | 74.60 |  |
| UOD | 74.61                         | 74.62 | 74.63 | 74.64 | 74.65 | 74.66 | 74.67 | 74.68 | 74.69 |  |
| UOK | 74.70                         | 74.71 | 74.72 | 74.73 | 74.74 | 74.75 | 74.76 | 74.77 | 74.78 |  |
| UOG | 74.79                         | 74.80 | 74.81 | 74.82 | 74.83 | 74.84 | 74.85 | 74.86 | 74.87 |  |
| UOO | 74.88                         | 74.89 | 74.90 | 74.91 | 74.92 | 74.93 | 74.94 | 74.95 | 74.96 |  |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

POSEMOUNT CALIBRATION RESULTS S/N 149-03 DATE 02 NOV 76 PAGE 5

|     | ALTITUDE IN THOUSANDS OF FEET |       |       |       |       |       |       |       |       |       |
|-----|-------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|     | S                             | V     | P     | M     | D     | K     | G     | O     |       |       |
| RSS | 74.76                         | 74.77 | 74.78 | 74.79 | 74.80 | 74.81 | 74.81 | 74.81 | 74.81 | 74.81 |
| RSU | 74.83                         | 74.84 | 74.85 | 74.86 | 74.87 | 74.87 | 74.87 | 74.87 | 74.87 | 74.87 |
| RSV | 74.90                         | 74.91 | 74.92 | 74.93 | 74.94 | 74.94 | 74.94 | 74.94 | 74.94 | 74.94 |
| RSM | 74.97                         | 74.98 | 74.99 | 75.00 | 75.01 | 75.01 | 75.01 | 75.01 | 75.01 | 75.01 |
| RSD | 75.04                         | 75.05 | 75.06 | 75.07 | 75.07 | 75.08 | 75.08 | 75.08 | 75.08 | 75.08 |
| RSK | 75.11                         | 75.12 | 75.13 | 75.14 | 75.15 | 75.15 | 75.15 | 75.15 | 75.15 | 75.15 |
| RSQ | 75.18                         | 75.19 | 75.20 | 75.21 | 75.22 | 75.22 | 75.22 | 75.22 | 75.22 | 75.22 |
| RST | 75.25                         | 75.26 | 75.27 | 75.28 | 75.29 | 75.29 | 75.29 | 75.29 | 75.29 | 75.29 |
| RUS | 75.32                         | 75.33 | 75.34 | 75.35 | 75.36 | 75.37 | 75.37 | 75.37 | 75.37 | 75.37 |
| RUV | 75.39                         | 75.40 | 75.41 | 75.42 | 75.43 | 75.44 | 75.44 | 75.44 | 75.44 | 75.44 |
| RUR | 75.46                         | 75.47 | 75.48 | 75.49 | 75.50 | 75.51 | 75.51 | 75.51 | 75.51 | 75.51 |
| RUM | 75.54                         | 75.55 | 75.56 | 75.57 | 75.58 | 75.59 | 75.59 | 75.59 | 75.59 | 75.59 |
| RUD | 75.61                         | 75.62 | 75.63 | 75.64 | 75.65 | 75.66 | 75.66 | 75.66 | 75.66 | 75.66 |
| RUK | 75.68                         | 75.69 | 75.70 | 75.71 | 75.72 | 75.73 | 75.73 | 75.73 | 75.73 | 75.73 |
| RUG | 75.75                         | 75.76 | 75.77 | 75.78 | 75.79 | 75.80 | 75.80 | 75.80 | 75.80 | 75.80 |
| RUD | 75.83                         | 75.84 | 75.85 | 75.86 | 75.87 | 75.88 | 75.88 | 75.88 | 75.88 | 75.88 |
| RPS | 75.90                         | 75.91 | 75.92 | 75.93 | 75.94 | 75.95 | 75.95 | 75.95 | 75.95 | 75.95 |
| PRU | 75.97                         | 75.98 | 75.99 | 76.00 | 76.01 | 76.02 | 76.02 | 76.02 | 76.02 | 76.02 |
| PRV | 76.05                         | 76.06 | 76.07 | 76.08 | 76.09 | 76.10 | 76.10 | 76.10 | 76.10 | 76.10 |
| PRM | 76.12                         | 76.13 | 76.14 | 76.15 | 76.16 | 76.17 | 76.17 | 76.17 | 76.17 | 76.17 |
| PRD | 76.20                         | 76.21 | 76.22 | 76.23 | 76.24 | 76.25 | 76.25 | 76.25 | 76.25 | 76.25 |
| PRK | 76.27                         | 76.28 | 76.29 | 76.30 | 76.31 | 76.32 | 76.32 | 76.32 | 76.32 | 76.32 |
| PRG | 76.35                         | 76.36 | 76.37 | 76.38 | 76.39 | 76.40 | 76.40 | 76.40 | 76.40 | 76.40 |
| PRQ | 76.43                         | 76.44 | 76.45 | 76.46 | 76.47 | 76.48 | 76.48 | 76.48 | 76.48 | 76.48 |
| RNS | 76.50                         | 76.51 | 76.52 | 76.53 | 76.54 | 76.55 | 76.55 | 76.55 | 76.55 | 76.55 |
| RNU | 76.58                         | 76.59 | 76.60 | 76.61 | 76.62 | 76.63 | 76.63 | 76.63 | 76.63 | 76.63 |
| RNR | 76.66                         | 76.67 | 76.68 | 76.69 | 76.70 | 76.71 | 76.71 | 76.71 | 76.71 | 76.71 |
| RNV | 76.74                         | 76.75 | 76.76 | 76.77 | 76.78 | 76.79 | 76.79 | 76.79 | 76.79 | 76.79 |
| RND | 76.82                         | 76.83 | 76.84 | 76.85 | 76.86 | 76.87 | 76.87 | 76.87 | 76.87 | 76.87 |
| RNK | 76.90                         | 76.91 | 76.92 | 76.93 | 76.94 | 76.95 | 76.95 | 76.95 | 76.95 | 76.95 |
| RNG | 76.98                         | 76.99 | 77.00 | 77.01 | 77.02 | 77.03 | 77.03 | 77.03 | 77.03 | 77.03 |
| RNO | 77.05                         | 77.06 | 77.07 | 77.08 | 77.09 | 77.10 | 77.11 | 77.11 | 77.11 | 77.11 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS SYN 149-83 DATE 12 NOV 76 PAGE 5

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | O     | M     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| RDS | 77.18 | 77.15 | 77.16 | 77.17 | 77.18 | 77.19 | 77.20 | 77.21 |
| RDU | 77.22 | 77.23 | 77.24 | 77.25 | 77.26 | 77.27 | 77.28 | 77.29 |
| RDR | 77.30 | 77.31 | 77.32 | 77.33 | 77.34 | 77.35 | 77.36 | 77.37 |
| RDM | 77.38 | 77.39 | 77.40 | 77.41 | 77.42 | 77.43 | 77.44 | 77.45 |
| RDU | 77.46 | 77.47 | 77.48 | 77.49 | 77.50 | 77.51 | 77.52 | 77.53 |
| RDK | 77.54 | 77.55 | 77.56 | 77.57 | 77.58 | 77.59 | 77.60 | 77.61 |
| RDE | 77.63 | 77.64 | 77.65 | 77.66 | 77.67 | 77.68 | 77.69 | 77.70 |
| RDO | 77.71 | 77.72 | 77.73 | 77.74 | 77.75 | 77.76 | 77.77 | 77.78 |
| RKS | 77.79 | 77.80 | 77.81 | 77.82 | 77.83 | 77.84 | 77.85 | 77.86 |
| RKU | 77.88 | 77.89 | 77.90 | 77.91 | 77.92 | 77.93 | 77.94 | 77.95 |
| RKR | 77.96 | 77.97 | 77.98 | 77.99 | 78.00 | 78.01 | 78.02 | 78.03 |
| RKM | 78.05 | 78.06 | 78.07 | 78.08 | 78.09 | 78.10 | 78.11 | 78.12 |
| RKO | 78.14 | 78.15 | 78.16 | 78.17 | 78.18 | 78.19 | 78.20 | 78.21 |
| RKK | 78.23 | 78.24 | 78.25 | 78.26 | 78.27 | 78.28 | 78.29 | 78.30 |
| RKG | 78.31 | 78.32 | 78.33 | 78.34 | 78.35 | 78.36 | 78.37 | 78.38 |
| RKO | 78.40 | 78.41 | 78.42 | 78.43 | 78.44 | 78.45 | 78.46 | 78.47 |
| RGS | 78.49 | 78.50 | 78.51 | 78.52 | 78.53 | 78.54 | 78.55 | 78.56 |
| RGU | 78.58 | 78.59 | 78.60 | 78.61 | 78.62 | 78.63 | 78.64 | 78.65 |
| RGR | 78.67 | 78.68 | 78.69 | 78.70 | 78.71 | 78.72 | 78.73 | 78.74 |
| RGW | 78.76 | 78.77 | 78.78 | 78.79 | 78.80 | 78.81 | 78.82 | 78.83 |
| RGO | 78.85 | 78.86 | 78.87 | 78.88 | 78.89 | 78.90 | 78.91 | 78.92 |
| RGE | 78.94 | 78.95 | 78.96 | 78.97 | 78.98 | 78.99 | 79.00 | 79.01 |
| RGG | 79.04 | 79.05 | 79.06 | 79.07 | 79.08 | 79.09 | 79.10 | 79.11 |
| RGO | 79.13 | 79.14 | 79.15 | 79.16 | 79.17 | 79.18 | 79.19 | 79.20 |
| RDS | 79.22 | 79.23 | 79.24 | 79.25 | 79.26 | 79.27 | 79.28 | 79.29 |
| RDU | 79.31 | 79.32 | 79.33 | 79.34 | 79.35 | 79.36 | 79.37 | 79.38 |
| RDR | 79.41 | 79.42 | 79.43 | 79.44 | 79.45 | 79.46 | 79.47 | 79.48 |
| RDM | 79.50 | 79.51 | 79.52 | 79.53 | 79.54 | 79.55 | 79.56 | 79.57 |
| RDU | 79.59 | 79.60 | 79.61 | 79.62 | 79.63 | 79.64 | 79.65 | 79.66 |
| RDK | 79.69 | 79.70 | 79.71 | 79.72 | 79.73 | 79.74 | 79.75 | 79.76 |
| RDE | 79.79 | 79.80 | 79.81 | 79.82 | 79.83 | 79.84 | 79.85 | 79.86 |
| RDO | 79.89 | 79.90 | 79.91 | 79.92 | 79.93 | 79.94 | 79.95 | 79.96 |

ROSEPOINT CALIBRATION RESULTS S/N 149-03 DATE 02 NOV 76 PAGE 7

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | R     | M     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| MS  | 79.97 | 79.98 | 79.99 | 80.01 | 80.12 | 80.03 | 80.75 | 80.03 |
| MSU | 80.06 | 80.38 | 80.09 | 80.10 | 80.11 | 80.12 | 80.13 | 80.13 |
| MSR | 80.16 | 80.17 | 80.18 | 80.19 | 80.20 | 80.21 | 80.22 | 80.23 |
| MSM | 80.25 | 80.26 | 80.28 | 80.29 | 80.30 | 80.31 | 80.32 | 80.33 |
| MSD | 80.35 | 80.36 | 80.37 | 80.38 | 80.39 | 80.40 | 80.41 | 80.42 |
| MSK | 80.44 | 80.45 | 80.46 | 80.47 | 80.48 | 80.49 | 80.50 | 80.51 |
| MSG | 80.53 | 80.54 | 80.55 | 80.56 | 80.57 | 80.58 | 80.59 | 80.60 |
| MSO | 80.63 | 80.64 | 80.65 | 80.66 | 80.67 | 80.68 | 80.69 | 80.70 |
| MUS | 80.73 | 80.74 | 80.75 | 80.76 | 80.77 | 80.78 | 80.79 | 80.80 |
| MUR | 80.82 | 80.83 | 80.84 | 80.85 | 80.86 | 80.87 | 80.88 | 80.89 |
| MUR | 80.92 | 80.93 | 80.94 | 80.95 | 80.96 | 80.97 | 80.98 | 80.99 |
| MUM | 81.01 | 81.02 | 81.03 | 81.04 | 81.05 | 81.06 | 81.07 | 81.08 |
| MUD | 81.11 | 81.12 | 81.13 | 81.14 | 81.15 | 81.16 | 81.17 | 81.18 |
| MUK | 81.21 | 81.22 | 81.23 | 81.24 | 81.25 | 81.26 | 81.27 | 81.28 |
| MUG | 81.31 | 81.32 | 81.33 | 81.34 | 81.35 | 81.36 | 81.37 | 81.38 |
| MUO | 81.40 | 81.41 | 81.42 | 81.43 | 81.44 | 81.45 | 81.46 | 81.47 |
| MPS | 81.50 | 81.51 | 81.52 | 81.53 | 81.54 | 81.55 | 81.56 | 81.57 |
| MPU | 81.60 | 81.61 | 81.62 | 81.63 | 81.64 | 81.65 | 81.66 | 81.67 |
| MPR | 81.70 | 81.71 | 81.72 | 81.73 | 81.74 | 81.75 | 81.76 | 81.77 |
| MPM | 81.80 | 81.81 | 81.82 | 81.83 | 81.84 | 81.85 | 81.86 | 81.87 |
| MPD | 81.90 | 81.91 | 81.92 | 81.93 | 81.94 | 81.95 | 81.96 | 81.97 |
| MPK | 82.01 | 82.02 | 82.03 | 82.04 | 82.05 | 82.06 | 82.07 | 82.08 |
| MPG | 82.11 | 82.12 | 82.13 | 82.14 | 82.15 | 82.16 | 82.17 | 82.18 |
| MPO | 82.21 | 82.22 | 82.23 | 82.24 | 82.25 | 82.26 | 82.27 | 82.28 |
| MWS | 82.31 | 82.32 | 82.33 | 82.34 | 82.35 | 82.36 | 82.37 | 82.38 |
| WU  | 82.42 | 82.43 | 82.44 | 82.45 | 82.46 | 82.47 | 82.48 | 82.49 |
| WUR | 82.52 | 82.53 | 82.54 | 82.55 | 82.56 | 82.57 | 82.58 | 82.59 |
| WM  | 82.63 | 82.64 | 82.65 | 82.66 | 82.67 | 82.68 | 82.69 | 82.70 |
| WUO | 82.73 | 82.74 | 82.75 | 82.76 | 82.77 | 82.78 | 82.79 | 82.80 |
| WUR | 82.84 | 82.85 | 82.86 | 82.87 | 82.88 | 82.89 | 82.90 | 82.91 |
| WUG | 82.95 | 82.96 | 82.97 | 82.98 | 82.99 | 83.00 | 83.01 | 83.02 |
| WUO | 83.06 | 83.07 | 83.08 | 83.09 | 83.10 | 83.11 | 83.12 | 83.13 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS S/N 149-03 DATE 12 NOV 76 PAGE 8

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | R     | W     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| WDS | 83.17 | 83.14 | 83.19 | 83.21 | 83.22 | 83.23 | 83.25 | 83.26 |
| WDU | 83.27 | 83.29 | 83.30 | 83.32 | 83.33 | 83.34 | 83.36 | 83.37 |
| WDR | 83.38 | 83.40 | 83.41 | 83.43 | 83.44 | 83.45 | 83.47 | 83.48 |
| WDM | 83.50 | 83.51 | 83.52 | 83.54 | 83.55 | 83.56 | 83.58 | 83.59 |
| WDD | 83.61 | 83.62 | 83.63 | 83.65 | 83.66 | 83.68 | 83.69 | 83.70 |
| WOK | 83.72 | 83.73 | 83.75 | 83.76 | 83.77 | 83.79 | 83.80 | 83.82 |
| WOG | 83.83 | 83.85 | 83.86 | 83.87 | 83.89 | 83.90 | 83.92 | 83.93 |
| WOO | 83.95 | 83.96 | 83.97 | 83.99 | 84.00 | 84.02 | 84.03 | 84.05 |
| WKS | 84.06 | 84.07 | 84.09 | 84.10 | 84.12 | 84.13 | 84.15 | 84.16 |
| WKU | 84.18 | 84.19 | 84.21 | 84.22 | 84.23 | 84.25 | 84.26 | 84.28 |
| WKR | 84.29 | 84.31 | 84.32 | 84.34 | 84.35 | 84.37 | 84.39 | 84.40 |
| WKW | 84.41 | 84.43 | 84.44 | 84.45 | 84.47 | 84.48 | 84.50 | 84.51 |
| WKO | 84.53 | 84.54 | 84.56 | 84.57 | 84.59 | 84.60 | 84.62 | 84.63 |
| WKK | 84.65 | 84.66 | 84.68 | 84.69 | 84.71 | 84.72 | 84.74 | 84.75 |
| WKG | 84.77 | 84.78 | 84.80 | 84.81 | 84.83 | 84.84 | 84.86 | 84.87 |
| WKO | 84.89 | 84.90 | 84.92 | 84.93 | 84.95 | 84.96 | 84.98 | 84.99 |
| WGS | 85.01 | 85.02 | 85.04 | 85.05 | 85.07 | 85.08 | 85.10 | 85.11 |
| WGU | 85.13 | 85.15 | 85.16 | 85.18 | 85.19 | 85.21 | 85.22 | 85.24 |
| WGR | 85.25 | 85.27 | 85.28 | 85.30 | 85.31 | 85.33 | 85.34 | 85.36 |
| WGW | 85.38 | 85.39 | 85.41 | 85.42 | 85.44 | 85.45 | 85.47 | 85.48 |
| WGD | 85.50 | 85.51 | 85.53 | 85.55 | 85.56 | 85.58 | 85.59 | 85.61 |
| WOK | 85.62 | 85.64 | 85.65 | 85.67 | 85.68 | 85.70 | 85.72 | 85.73 |
| WOG | 85.75 | 85.76 | 85.78 | 85.79 | 85.81 | 85.83 | 85.84 | 85.86 |
| WOO | 85.87 | 85.89 | 85.90 | 85.92 | 85.94 | 85.95 | 85.97 | 85.99 |
| WOS | 86.00 | 86.01 | 86.03 | 86.04 | 86.06 | 86.09 | 86.10 | 86.11 |
| WOU | 86.12 | 86.14 | 86.15 | 86.17 | 86.19 | 86.21 | 86.23 | 86.24 |
| WOR | 86.25 | 86.26 | 86.28 | 86.29 | 86.31 | 86.32 | 86.34 | 86.35 |
| WOW | 86.37 | 86.39 | 86.40 | 86.42 | 86.43 | 86.45 | 86.46 | 86.48 |
| WOD | 86.50 | 86.51 | 86.53 | 86.54 | 86.56 | 86.57 | 86.59 | 86.60 |
| WOK | 86.62 | 86.64 | 86.65 | 86.67 | 86.69 | 86.70 | 86.72 | 86.73 |
| WOG | 86.75 | 86.77 | 86.78 | 86.80 | 86.81 | 86.83 | 86.85 | 86.86 |
| WOO | 86.88 | 86.89 | 86.91 | 86.93 | 86.94 | 86.96 | 86.97 | 86.99 |

ROSEHOUNT CALIBRATION RESULTS S/N 149-02 DATE 12 NOV 76 PAGE 9

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | R     | M     | N     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| DSS | 87.01 | 87.02 | 87.04 | 87.06 | 87.07 | 87.09 | 87.10 | 87.12 |
| DSU | 87.14 | 87.15 | 87.17 | 87.19 | 87.20 | 87.22 | 87.23 | 87.25 |
| DSR | 87.27 | 87.28 | 87.30 | 87.32 | 87.33 | 87.35 | 87.37 | 87.38 |
| DSM | 87.40 | 87.42 | 87.43 | 87.45 | 87.47 | 87.49 | 87.51 | 87.53 |
| DSO | 87.53 | 87.55 | 87.57 | 87.58 | 87.61 | 87.62 | 87.63 | 87.65 |
| DSK | 87.67 | 87.68 | 87.70 | 87.72 | 87.74 | 87.76 | 87.77 | 87.79 |
| DSG | 87.80 | 87.82 | 87.84 | 87.85 | 87.87 | 87.89 | 87.91 | 87.92 |
| DSO | 87.94 | 87.96 | 87.97 | 87.99 | 88.01 | 88.03 | 88.04 | 88.06 |
| DUS | 88.08 | 88.10 | 88.11 | 88.13 | 88.15 | 88.17 | 88.18 | 88.20 |
| DUU | 88.22 | 88.24 | 88.26 | 88.27 | 88.29 | 88.31 | 88.32 | 88.34 |
| DUR | 88.36 | 88.38 | 88.40 | 88.42 | 88.43 | 88.45 | 88.47 | 88.49 |
| DUM | 88.51 | 88.52 | 88.54 | 88.56 | 88.58 | 88.60 | 88.61 | 88.63 |
| DUD | 88.65 | 88.67 | 88.69 | 88.71 | 88.73 | 88.75 | 88.76 | 88.78 |
| DUK | 88.80 | 88.82 | 88.83 | 88.85 | 88.87 | 88.89 | 88.91 | 88.93 |
| DUG | 88.95 | 88.96 | 88.98 | 89.00 | 89.02 | 89.04 | 89.06 | 89.08 |
| DUO | 89.09 | 89.11 | 89.13 | 89.15 | 89.17 | 89.19 | 89.21 | 89.23 |
| DVS | 89.25 | 89.26 | 89.28 | 89.30 | 89.32 | 89.34 | 89.36 | 89.38 |
| DRU | 89.40 | 89.42 | 89.44 | 89.46 | 89.47 | 89.49 | 89.51 | 89.53 |
| DRE | 89.55 | 89.57 | 89.59 | 89.61 | 89.63 | 89.65 | 89.67 | 89.69 |
| DRM | 89.71 | 89.73 | 89.75 | 89.77 | 89.79 | 89.81 | 89.83 | 89.85 |
| DRO | 89.86 | 89.88 | 89.90 | 89.92 | 89.94 | 89.96 | 89.98 | 90.00 |
| DRK | 90.02 | 90.04 | 90.06 | 90.08 | 90.10 | 90.13 | 90.15 | 90.17 |
| DRG | 90.19 | 90.21 | 90.23 | 90.25 | 90.27 | 90.29 | 90.31 | 90.33 |
| DRO | 90.35 | 90.37 | 90.39 | 90.41 | 90.43 | 90.45 | 90.47 | 90.49 |
| DWS | 90.52 | 90.54 | 90.56 | 90.58 | 90.60 | 90.62 | 90.64 | 90.66 |
| DWU | 90.68 | 90.70 | 90.72 | 90.75 | 90.77 | 90.79 | 90.81 | 90.83 |
| DWR | 90.85 | 90.87 | 90.89 | 90.92 | 90.94 | 90.96 | 90.98 | 91.00 |
| DWM | 91.02 | 91.04 | 91.06 | 91.09 | 91.11 | 91.13 | 91.15 | 91.17 |
| DWO | 91.19 | 91.21 | 91.23 | 91.26 | 91.28 | 91.30 | 91.32 | 91.34 |
| DWK | 91.36 | 91.38 | 91.41 | 91.43 | 91.45 | 91.47 | 91.49 | 91.51 |
| DWG | 91.53 | 91.56 | 91.58 | 91.60 | 91.62 | 91.64 | 91.66 | 91.68 |
| DWO | 91.71 | 91.73 | 91.75 | 91.77 | 91.79 | 91.82 | 91.84 | 91.86 |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

ROSEMOUNT CALIBRATION RESULTS S/N 189-03 DATE 12 NOV 76 PAG 10

ALTITUDE IN THOUSANDS OF FEET

|     | S     | U     | P     | W     | D     | K     | G     | O     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| DOS | 91.88 | 91.90 | 91.92 | 91.95 | 91.97 | 91.99 | 92.01 | 92.03 |
| DOU | 92.05 | 92.07 | 92.10 | 92.12 | 92.14 | 92.16 | 92.18 | 92.20 |
| DOV | 92.22 | 92.24 | 92.26 | 92.29 | 92.31 | 92.33 | 92.35 | 92.37 |
| DOX | 92.39 | 92.41 | 92.43 | 92.46 | 92.48 | 92.51 | 92.52 | 92.54 |
| DOY | 92.56 | 92.58 | 92.61 | 92.63 | 92.65 | 92.67 | 92.69 | 92.71 |
| DOZ | 92.73 | 92.76 | 92.78 | 92.80 | 92.82 | 92.84 | 92.86 | 92.88 |
| DOA | 92.91 | 92.93 | 92.95 | 92.97 | 92.99 | 93.02 | 93.04 | 93.06 |
| DOB | 93.08 | 93.10 | 93.12 | 93.15 | 93.17 | 93.19 | 93.21 | 93.23 |
| DOS | 93.26 | 93.28 | 93.30 | 93.32 | 93.35 | 93.37 | 93.39 | 93.41 |
| DOU | 93.43 | 93.46 | 93.48 | 93.50 | 93.52 | 93.55 | 93.57 | 93.59 |
| DOV | 93.61 | 93.64 | 93.66 | 93.68 | 93.70 | 93.73 | 93.75 | 93.77 |
| DOX | 93.79 | 93.82 | 93.84 | 93.86 | 93.89 | 93.91 | 93.93 | 93.95 |
| DOY | 93.98 | 94.00 | 94.02 | 94.05 | 94.07 | 94.09 | 94.12 | 94.14 |
| DOZ | 94.16 | 94.19 | 94.21 | 94.23 | 94.26 | 94.28 | 94.31 | 94.33 |
| DOA | 94.35 | 94.37 | 94.40 | 94.42 | 94.44 | 94.47 | 94.49 | 94.51 |
| DOB | 94.54 | 94.56 | 94.59 | 94.61 | 94.63 | 94.66 | 94.69 | 94.71 |
| DOS | 94.73 | 94.75 | 94.78 | 94.80 | 94.83 | 94.85 | 94.88 | 94.90 |
| DOU | 94.93 | 94.95 | 94.98 | 95.00 | 95.02 | 95.05 | 95.08 | 95.10 |
| DOV | 95.13 | 95.15 | 95.18 | 95.20 | 95.23 | 95.25 | 95.28 | 95.30 |
| DOX | 95.33 | 95.35 | 95.38 | 95.41 | 95.43 | 95.45 | 95.48 | 95.50 |
| DOY | 95.54 | 95.56 | 95.59 | 95.61 | 95.64 | 95.67 | 95.69 | 95.72 |
| DOZ | 95.75 | 95.77 | 95.80 | 95.82 | 95.85 | 95.88 | 95.91 | 95.93 |
| DOA | 95.96 | 95.99 | 96.02 | 96.05 | 96.07 | 96.10 | 96.13 | 96.15 |
| DOB | 96.19 | 96.22 | 96.25 | 96.28 | 96.30 | 96.33 | 96.35 | 96.38 |
| DOS | 96.42 | 96.45 | 96.48 | 96.51 | 96.54 | 96.57 | 96.59 | 96.62 |
| DOU | 96.66 | 96.69 | 96.72 | 96.75 | 96.78 | 96.81 | 96.84 | 96.87 |
| DOV | 96.90 | 96.93 | 96.96 | 96.99 | 97.02 | 97.05 | 97.08 | 97.11 |
| DOX | 97.14 | 97.17 | 97.20 | 97.23 | 97.26 | 97.29 | 97.32 | 97.35 |
| DOY | 97.38 | 97.42 | 97.45 | 97.48 | 97.51 | 97.54 | 97.57 | 97.60 |
| DOZ | 97.63 | 97.66 | 97.69 | 97.73 | 97.76 | 97.79 | 97.82 | 97.85 |
| DOA | 97.88 | 97.91 | 97.94 | 97.98 | 98.01 | 98.04 | 98.07 | 98.10 |
| DOB | 98.13 | 98.16 | 98.21 | 98.23 | 98.26 | 98.29 | 98.32 | 98.35 |

ROSEMOUNT CALIBRATION RESULTS S/N 149-03 DATE 12 NOV 76 PAGE 11

| ALTITUDE IN THOUSANDS OF FEET |        |        |        |        |        |        |        |        |        |        |
|-------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| S                             | U      | R      | W      | D      | K      | G      | O      |        |        |        |
| KSS                           | 98.39  | 98.42  | 98.45  | 98.48  | 98.51  | 98.54  | 98.57  | 98.60  | 98.63  | 98.66  |
| KSU                           | 98.64  | 98.67  | 98.70  | 98.73  | 98.76  | 98.79  | 98.82  | 98.85  | 98.88  | 98.91  |
| KSV                           | 98.94  | 98.97  | 99.00  | 99.03  | 99.06  | 99.09  | 99.12  | 99.15  | 99.18  | 99.21  |
| KSW                           | 99.15  | 99.18  | 99.21  | 99.24  | 99.27  | 99.30  | 99.33  | 99.36  | 99.39  | 99.42  |
| KSD                           | 99.40  | 99.43  | 99.46  | 99.49  | 99.52  | 99.55  | 99.58  | 99.61  | 99.64  | 99.67  |
| KSE                           | 99.65  | 99.68  | 99.71  | 99.74  | 99.77  | 99.80  | 99.83  | 99.86  | 99.89  | 99.92  |
| KSF                           | 99.91  | 99.94  | 99.97  | 100.00 | 100.03 | 100.06 | 100.09 | 100.12 | 100.15 | 100.18 |
| KSG                           | 100.16 | 100.19 | 100.22 | 100.25 | 100.28 | 100.31 | 100.34 | 100.37 | 100.40 | 100.43 |
| KSH                           | 100.44 | 100.47 | 100.50 | 100.53 | 100.56 | 100.59 | 100.62 | 100.65 | 100.68 | 100.71 |
| KSI                           | 100.76 | 100.79 | 100.82 | 100.85 | 100.88 | 100.91 | 100.94 | 100.97 | 101.00 | 101.03 |
| KSJ                           | 101.06 | 101.09 | 101.12 | 101.15 | 101.18 | 101.21 | 101.24 | 101.27 | 101.30 | 101.33 |
| KSK                           | 101.36 | 101.39 | 101.42 | 101.45 | 101.48 | 101.51 | 101.54 | 101.57 | 101.60 | 101.63 |
| KSL                           | 101.66 | 101.69 | 101.72 | 101.75 | 101.78 | 101.81 | 101.84 | 101.87 | 101.90 | 101.93 |
| KSM                           | 101.96 | 101.99 | 102.02 | 102.05 | 102.08 | 102.11 | 102.14 | 102.17 | 102.20 | 102.23 |
| KSN                           | 102.26 | 102.29 | 102.32 | 102.35 | 102.38 | 102.41 | 102.44 | 102.47 | 102.50 | 102.53 |
| KSO                           | 102.56 | 102.59 | 102.62 | 102.65 | 102.68 | 102.71 | 102.74 | 102.77 | 102.80 | 102.83 |
| KSP                           | 102.86 | 102.89 | 102.92 | 102.95 | 102.98 | 103.01 | 103.04 | 103.07 | 103.10 | 103.13 |
| KSQ                           | 103.16 | 103.19 | 103.22 | 103.25 | 103.28 | 103.31 | 103.34 | 103.37 | 103.40 | 103.43 |
| KSR                           | 103.46 | 103.49 | 103.52 | 103.55 | 103.58 | 103.61 | 103.64 | 103.67 | 103.70 | 103.73 |
| KSS                           | 103.76 | 103.79 | 103.82 | 103.85 | 103.88 | 103.91 | 103.94 | 103.97 | 104.00 | 104.03 |
| KST                           | 104.06 | 104.09 | 104.12 | 104.15 | 104.18 | 104.21 | 104.24 | 104.27 | 104.30 | 104.33 |
| KSU                           | 104.36 | 104.39 | 104.42 | 104.45 | 104.48 | 104.51 | 104.54 | 104.57 | 104.60 | 104.63 |
| KSV                           | 104.66 | 104.69 | 104.72 | 104.75 | 104.78 | 104.81 | 104.84 | 104.87 | 104.90 | 104.93 |
| KSW                           | 104.96 | 104.99 | 105.02 | 105.05 | 105.08 | 105.11 | 105.14 | 105.17 | 105.20 | 105.23 |
| KSD                           | 105.26 | 105.29 | 105.32 | 105.35 | 105.38 | 105.41 | 105.44 | 105.47 | 105.50 | 105.53 |
| KSE                           | 105.56 | 105.59 | 105.62 | 105.65 | 105.68 | 105.71 | 105.74 | 105.77 | 105.80 | 105.83 |
| KSF                           | 105.86 | 105.89 | 105.92 | 105.95 | 105.98 | 106.01 | 106.04 | 106.07 | 106.10 | 106.13 |
| KSG                           | 106.16 | 106.19 | 106.22 | 106.25 | 106.28 | 106.31 | 106.34 | 106.37 | 106.40 | 106.43 |
| KSH                           | 106.46 | 106.49 | 106.52 | 106.55 | 106.58 | 106.61 | 106.64 | 106.67 | 106.70 | 106.73 |
| KSI                           | 106.76 | 106.79 | 106.82 | 106.85 | 106.88 | 106.91 | 106.94 | 106.97 | 107.00 | 107.03 |
| KSJ                           | 107.06 | 107.09 | 107.12 | 107.15 | 107.18 | 107.21 | 107.24 | 107.27 | 107.30 | 107.33 |
| KSK                           | 107.36 | 107.39 | 107.42 | 107.45 | 107.48 | 107.51 | 107.54 | 107.57 | 107.60 | 107.63 |
| KSL                           | 107.66 | 107.69 | 107.72 | 107.75 | 107.78 | 107.81 | 107.84 | 107.87 | 107.90 | 107.93 |
| KSM                           | 107.96 | 107.99 | 108.02 | 108.05 | 108.08 | 108.11 | 108.14 | 108.17 | 108.20 | 108.23 |
| KSN                           | 108.26 | 108.29 | 108.32 | 108.35 | 108.38 | 108.41 | 108.44 | 108.47 | 108.50 | 108.53 |
| KSO                           | 108.56 | 108.59 | 108.62 | 108.65 | 108.68 | 108.71 | 108.74 | 108.77 | 108.80 | 108.83 |
| KSP                           | 108.86 | 108.89 | 108.92 | 108.95 | 108.98 | 109.01 | 109.04 | 109.07 | 109.10 | 109.13 |
| KSQ                           | 109.16 | 109.19 | 109.22 | 109.25 | 109.28 | 109.31 | 109.34 | 109.37 | 109.40 | 109.43 |
| KSR                           | 109.46 | 109.49 | 109.52 | 109.55 | 109.58 | 109.61 | 109.64 | 109.67 | 109.70 | 109.73 |
| KSS                           | 109.76 | 109.79 | 109.82 | 109.85 | 109.88 | 109.91 | 109.94 | 109.97 | 110.00 | 110.03 |
| KST                           | 110.06 | 110.09 | 110.12 | 110.15 | 110.18 | 110.21 | 110.24 | 110.27 | 110.30 | 110.33 |
| KSU                           | 110.36 | 110.39 | 110.42 | 110.45 | 110.48 | 110.51 | 110.54 | 110.57 | 110.60 | 110.63 |
| KSV                           | 110.66 | 110.69 | 110.72 | 110.75 | 110.78 | 110.81 | 110.84 | 110.87 | 110.90 | 110.93 |
| KSW                           | 110.96 | 110.99 | 111.02 | 111.05 | 111.08 | 111.11 | 111.14 | 111.17 | 111.20 | 111.23 |
| KSD                           | 111.26 | 111.29 | 111.32 | 111.35 | 111.38 | 111.41 | 111.44 | 111.47 | 111.50 | 111.53 |
| KSE                           | 111.56 | 111.59 | 111.62 | 111.65 | 111.68 | 111.71 | 111.74 | 111.77 | 111.80 | 111.83 |
| KSF                           | 111.86 | 111.89 | 111.92 | 111.95 | 111.98 | 112.01 | 112.04 | 112.07 | 112.10 | 112.13 |
| KSG                           | 112.16 | 112.19 | 112.22 | 112.25 | 112.28 | 112.31 | 112.34 | 112.37 | 112.40 | 112.43 |
| KSH                           | 112.46 | 112.49 | 112.52 | 112.55 | 112.58 | 112.61 | 112.64 | 112.67 | 112.70 | 112.73 |
| KSI                           | 112.76 | 112.79 | 112.82 | 112.85 | 112.88 | 112.91 | 112.94 | 112.97 | 113.00 | 113.03 |
| KSJ                           | 113.06 | 113.09 | 113.12 | 113.15 | 113.18 | 113.21 | 113.24 | 113.27 | 113.30 | 113.33 |
| KSK                           | 113.36 | 113.39 | 113.42 | 113.45 | 113.48 | 113.51 | 113.54 | 113.57 | 113.60 | 113.63 |
| KSL                           | 113.66 | 113.69 | 113.72 | 113.75 | 113.78 | 113.81 | 113.84 | 113.87 | 113.90 | 113.93 |
| KSM                           | 113.96 | 113.99 | 114.02 | 114.05 | 114.08 | 114.11 | 114.14 | 114.17 | 114.20 | 114.23 |
| KSN                           | 114.26 | 114.29 | 114.32 | 114.35 | 114.38 | 114.41 | 114.44 | 114.47 | 114.50 | 114.53 |
| KSO                           | 114.56 | 114.59 | 114.62 | 114.65 | 114.68 | 114.71 | 114.74 | 114.77 | 114.80 | 114.83 |
| KSP                           | 114.86 | 114.89 | 114.92 | 114.95 | 114.98 | 115.01 | 115.04 | 115.07 | 115.10 | 115.13 |
| KSQ                           | 115.16 | 115.19 | 115.22 | 115.25 | 115.28 | 115.31 | 115.34 | 115.37 | 115.40 | 115.43 |
| KSR                           | 115.46 | 115.49 | 115.52 | 115.55 | 115.58 | 115.61 | 115.64 | 115.67 | 115.70 | 115.73 |
| KSS                           | 115.76 | 115.79 | 115.82 | 115.85 | 115.88 | 115.91 | 115.94 | 115.97 | 116.00 | 116.03 |
| KST                           | 116.06 | 116.09 | 116.12 | 116.15 | 116.18 | 116.21 | 116.24 | 116.27 | 116.30 | 116.33 |
| KSU                           | 116.36 | 116.39 | 116.42 | 116.45 | 116.48 | 116.51 | 116.54 | 116.57 | 116.60 | 116.63 |
| KSV                           | 116.66 | 116.69 | 116.72 | 116.75 | 116.78 | 116.81 | 116.84 | 116.87 | 116.90 | 116.93 |
| KSW                           | 116.96 | 116.99 | 117.02 | 117.05 | 117.08 | 117.11 | 117.14 | 117.17 | 117.20 | 117.23 |
| KSD                           | 117.26 | 117.29 | 117.32 | 117.35 | 117.38 | 117.41 | 117.44 | 117.47 | 117.50 | 117.53 |
| KSE                           | 117.56 | 117.59 | 117.62 | 117.65 | 117.68 | 117.71 | 117.74 | 117.77 | 117.80 | 117.83 |
| KSF                           | 117.86 | 117.89 | 117.92 | 117.95 | 117.98 | 118.01 | 118.04 | 118.07 | 118.10 | 118.13 |
| KSG                           | 118.16 | 118.19 | 118.22 | 118.25 | 118.28 | 118.31 | 118.34 | 118.37 | 118.40 | 118.43 |
| KSH                           | 118.46 | 118.49 | 118.52 | 118.55 | 118.58 | 118.61 | 118.64 | 118.67 | 118.70 | 118.73 |
| KSI                           | 118.76 | 118.79 | 118.82 | 118.85 | 118.88 | 118.91 | 118.94 | 118.97 | 119.00 | 119.03 |
| KSJ                           | 119.06 | 119.09 | 119.12 | 119.15 | 119.18 | 119.21 | 119.24 | 119.27 | 119.30 | 119.33 |
| KSK                           | 119.36 | 119.39 | 119.42 | 119.45 | 119.48 | 119.51 | 119.54 | 119.57 | 119.60 | 119.63 |
| KSL                           | 119.66 | 119.69 | 119.72 | 119.75 | 119.78 | 119.81 | 119.84 | 119.87 | 119.90 | 119.93 |
| KSM                           | 119.96 | 120.00 | 120.04 | 120.08 | 120.12 | 120.16 | 120.20 | 120.24 | 120.28 | 120.32 |
| KSN                           | 120.36 | 120.40 | 120.44 | 120.48 | 120.52 | 120.56 | 120.60 | 120.64 | 120.68 | 120.72 |
| KSO                           | 120.76 | 120.80 | 120.84 | 120.88 | 120.92 | 120.96 | 121.00 | 121.04 | 121.08 | 121.12 |
| KSP                           | 121.16 | 121.20 | 121.24 | 121.28 | 121.32 | 121.36 | 121.40 | 121.44 | 121.48 | 121.52 |
| KSQ                           | 121.56 | 121.60 | 121.64 | 121.68 | 121.72 | 121.76 | 121.80 | 121.84 | 121.88 | 121.92 |
| KSR                           | 121.96 | 122.00 | 122.04 | 122.08 | 122.12 | 122.16 | 122.20 | 122.24 | 122.28 | 122.32 |
| KSS                           | 122.36 | 122.40 | 122.44 | 122.48 | 122.52 | 122.56 | 122.60 | 122.64 | 122.68 | 122.72 |
| KST                           | 122.76 | 122.80 | 122.84 | 122.88 | 122.92 | 122.96 | 123.00 | 123.04 | 123.08 | 123.12 |
| KSU                           | 123.16 | 123.20 | 123.24 | 123.28 | 123.32 | 123.36 | 123.40 | 123.44 | 123.48 | 123.52 |
| KSV                           | 123.56 | 123.60 | 123.64 | 123.68 | 123.72 | 123.76 | 123.80 | 123.84 | 123.88 | 123.92 |
| KSW                           | 123.96 | 124.00 | 124.04 | 124.08 | 124.12 | 124.16 | 124.20 | 124.24 | 124.28 | 124.32 |
| KSD                           | 124.36 | 124.40 | 124.44 | 124.48 | 124.52 | 124.56 | 124.60 | 124.64 | 124.68 | 124.72 |
| KSE                           | 124.76 | 124.80 | 124.84 | 124.88 | 124.92 | 124.96 | 125.00 | 125.04 | 125.08 | 125.12 |
| KSF                           | 125.16 | 125.20 | 125.24 | 125.28 | 125.32 | 125.36 | 125.40 | 125.44 | 125.48 | 125.52 |
| KSG                           | 125.56 | 125.60 | 125.64 | 125.68 | 125.72 | 125.76 | 125.80 | 125.84 | 125.88 | 125.92 |
| KSH                           | 125.96 | 126.00 | 126.04 | 126.08 | 126.12 | 126.16 | 126.20 | 126.24 | 126.28 | 126.32 |
| KSI                           | 126.36 | 126.40 | 126.44 | 126.48 | 126.52 | 126.56 | 126.60 | 126.64 | 126.68 | 126.72 |
| KSJ                           | 126.76 | 126.80 | 126.84 | 126.88 | 126.92 | 126.96 | 127.00 | 127.04 | 127.08 | 127.12 |
| KSK                           | 127.16 | 127.20 | 127.24 | 127.28 | 127.32 | 127.36 | 127.40 | 127.44 | 127.48 | 127.52 |
| KSL                           | 127.56 | 127.60 | 127.64 | 127.68 | 127.72 | 127.76 | 127.80 | 127.84 | 127.88 | 127.92 |
| KSM                           | 127.96 | 128.00 | 128.04 | 128.08 | 128.12 | 128.16 | 128.20 | 128.24 | 128.28 | 128.32 |
| KSN                           | 128.36 | 128.40 | 128.44 | 128.48 | 128.52 | 128.56 | 128.60 | 128.64 | 128.68 | 128.72 |
| KSO                           | 128.76 | 128.80 | 128.84 | 128.88 | 128.92 | 128.96 | 129.00 | 129.04 | 129.08 | 129.12 |
| KSP                           | 129.16 | 129.20 | 129.24 | 129.28 | 129.32 | 129.36 | 129.40 | 129.44 | 129.48 | 129.52 |
| KSQ                           | 129.56 | 129.60 | 129.64 | 129.68 | 129.72 | 129.76 | 129.80 | 129.84 | 129.88 | 129.92 |
| KSR                           | 129.96 | 130.00 | 130.04 | 130.08 | 130.12 | 130.16 | 130.20 | 130.24 | 130.28 | 130.32 |
| KSS                           | 130.36 | 130.   |        |        |        |        |        |        |        |        |

THIS PAGE IS BEST QUALITY PRACTICABLE  
FROM COPY FURNISHED TO DDC

| M       | P      | COUNTS | M*      | M-M* |
|---------|--------|--------|---------|------|
| 68.000  | 93.560 | 21.4   | 60.000  | .000 |
| 68.000  | 93.590 | 28.6   | 60.000  | .000 |
| 68.000  | 98.690 | 39.3   | 64.000  | .000 |
| 68.000  | 98.220 | 58.4   | 66.000  | .000 |
| 68.000  | 15.290 | 130.0  | 68.000  | .000 |
| 78.000  | 4.888  | 489.2  | 70.000  | .000 |
| 78.000  | 2.904  | 688.7  | 72.000  | .000 |
| 78.000  | 2.182  | 933.7  | 74.000  | .000 |
| 78.000  | 1.728  | 1162.8 | 76.000  | .000 |
| 78.000  | 1.467  | 1363.3 | 78.000  | .000 |
| 88.000  | 1.300  | 1530.5 | 80.000  | .000 |
| 88.000  | 1.174  | 1703.6 | 82.000  | .000 |
| 88.000  | 1.080  | 1851.9 | 84.000  | .000 |
| 88.000  | 1.000  | 1994.1 | 86.000  | .000 |
| 88.000  | .949   | 2107.5 | 88.000  | .000 |
| 98.000  | .903   | 2214.8 | 90.000  | .000 |
| 98.000  | .866   | 2309.5 | 92.000  | .000 |
| 98.000  | .833   | 2401.0 | 94.000  | .000 |
| 98.000  | .806   | 2481.4 | 96.000  | .000 |
| 98.000  | .785   | 2547.8 | 98.000  | .000 |
| 108.000 | .766   | 2611.0 | 100.000 | .000 |

```

00.00.00.00 SCOPE 3.4.4 * C0C468A A.P.G.L.
00.00.00.00 C0R002K FROM WEA
00.00.00.00 00001344 WORDS - FILE INPUT , DC 30
00.00.00.00 C0R002K
00.00.00.00 203E C0RDELLA
00.00.00.00 00.00.36.C0PY8R, INPUT, XX, 3.
00.00.00.00 00.00.37.FTNG, SL.
00.00.00.00 .659 CP SECONDS COMPILE TIME
00.00.00.00 00.00.39.C0M, XX.
00.00.00.00 00.00.46.LGO.
00.00.00.00 STOP
00.00.00.00 2.264 CP SECONDS EXECUTION TIME
00.00.00.00 00.00.53.0P 00000000 WORDS - FILE OUTPUT , DC 10
00.00.00.00 00.00.53.0S 10752 WORDS ( 1792* MAX USED)
00.00.00.00 00.00.53.0M 3.578 SEC.
00.00.00.00 00.00.53.10 1.980 SEC.
00.00.00.00 00.00.54.0S 12.337 SEC.
00.00.00.00 00.00.54.0S COST OF JOB .177
00.00.00.00 00.00.54.0S COST OF JOB 12.001 SEC.
00.00.00.00 00.00.54.0S DATE 03/11/77
00.00.00.00 00.00.54.0S END OF JOB. **
00.00.00.00 C0R002K //// END OF LIST ////
00.00.00.00 C0R002K //// END OF LIST ////

```

## Appendix J

### Environmental Chamber Tests of PR-3 Flow Rate Sensors

#### J1. THE TEST

As noted in the text, this test was conducted to examine the interaction of the PR-3 flow sensor when used with the encoder designed to replace the PR-3 electronics. The usual PR-3 calibration system was set up. This system utilizes a Perkin 0-50 V, 0-20 A power supply to run the PRFTs. The magnetic tachometer in each PRFT was monitored by a General Radio 1192-B frequency counter and occasionally an oscilloscope. A PR-3 flow sensor was attached to each PRFT. The procedure used was as follows. First, the PR-3 flow sensor was connected to the PR-3 data recorder and calibrated at the proper pressure altitude. Next the PR-3 flow sensor was connected to the new instrumentation and its indicated frequency recorded. The information about the reed characteristic and the flow data channels was very informative. The test results are listed in the next section.

##### J1.1 Test Findings

Three separate points were surfaced by the test:

- (1) Both data encoder flow channels tested reacted the same way to any individual reed. This should have been the case because all the circuits were built with similar components: 5 percent resistors and 10 percent capacitors.

(2) The amount of contact bounce varied greatly from reed to reed. Of four PR-3 flow sensors checked, one (SN35) interfaced perfectly with the data encoder and produced accurate data with the PRFT turning at 60 Hz. However, the other three PR-3 flow sensors (SN's 58, 65, and 86) all produced data that was well above the correct value of frequency. The recorded frequency exceeded the control frequency by 23.7 percent, 35.2 percent, and 42.0 percent respectively at 60 Hz on the PRFT. It is logical for the data to be in error by having too high a value because if the effects of reed contact bounce are not eliminated prior to counting the data pulses, the pulses caused by the contact bounce will be counted as data pulses. The varying error for each reed demonstrates that the reeds have different amounts of contact bounce at the same frequency. Also, two of the four sensors produced data with standard deviations less than 1.00 while two (SN's 58 and 86) produced data with standard deviations greater than 4.00. All these sensors were checked on two identical circuits with the same results. This further demonstrates that, at the same frequency, there is a wide range of bounce characteristics for the reeds and, that the reed which was chosen by Litton Industries for use in the PR-3 Calibration Unit is not truly representative of the reeds used in the PR-3 flow sensors.

(3) The contact bounce characteristic of each reed varies with frequency. Two reeds were each checked at three flow rates (60, 75, and 90 Hz) and although both reeds produced high frequency readings when working into the data encoder the percentage of error between the reeds and the PRFT was very significantly different for each flow rate.

Even the direction of change in the percentage error was different. See Table J1.

Table J1. Flow Rate Errors

| Frequency | Error (SN58) | Error (SN65) |
|-----------|--------------|--------------|
| (Hz)      | Percent      | Percent      |
| 60        | 23.7         | 35.2         |
| 75        | 18.7         | 41.0         |
| 90        | 38.9         | 46.0         |

This characteristic does not effect the PR-3 data recorders because of the circuit they use to monitor the reeds and, it does not now effect the new data encoder either. However, it is important to document the bounce characteristics of this critical part of the system.

## J1.2 A Solution

The solution to the variation in reed characteristics was achieved at the environmental chamber. Using the previously described test set up the encoder flow data channel was examined with an oscilloscope while a particularly "bouncy" reed was being driven in the chamber. It was noted that when the flow data channel (see Figure J1) was switched into the main part of the encoder the current drawn by the transistor in the level shifting amplifier loaded the contact bounce smoothing circuit. This allowed the contact bounce to be amplified and enter the data counting circuit. The addition of a current limiting resistor into the transistor's base circuit reduced the loading of the preceding stage and eliminated the effect of the contact bounce on the flow data. Corroborative data is in Table J2.

Note that two of the units (SN's 58 and 86) used in the test previously produced data with a standard deviation greater than 4.0 but now produced data with a much more acceptable spread.

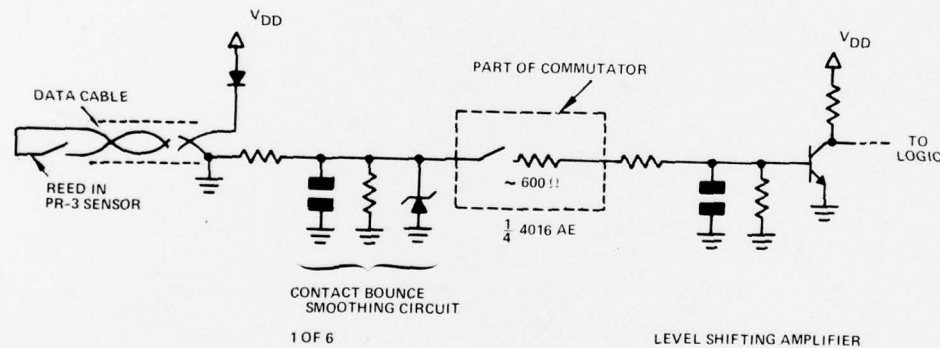


Figure J1. Typical Flow Rate Sensor Monitoring Circuit

Table J2. Test Results

| Flow Sensor |      | Control* |         |                    | *Data |
|-------------|------|----------|---------|--------------------|-------|
| SN          | PRFT | PR-3**   | Encoder | Standard Deviation |       |
| 35          | 60   | ---      | 57.0    | 0.524              |       |
| 86          | 60   | ---      | 54.7    | 0.285              |       |
| 65          | 60   | 54       | 54.1    | 0.300              |       |
| 58          | 61   | 55       | 56.3    | 0.409              |       |
| 58          | 90   | 88       | 89.1    | 0.401              |       |

\*Units are Hertz.

\*\*This is the PR-3 data recorder

## Appendix K

### Electrical Detonation of Primary and Secondary Separation Squibs

#### K1. GENERAL

The following information appeared as a Memo for Record, dated 1 May 1975.

#### K2. BACKGROUND

The primary and secondary separation squibs activated the primary and backup tenney release devices which are used to separate the parachute and its suspended load from the balloon bottom end fitting. Each squib is controlled by a completely independent system. Each system contains the wires to the squib, radio command or timer activated controller and, batteries. The only common point between the squibs is the electrical "ground". This "ground" is obviously not earth ground but a common point of reference arrived at by definition and utilized for batteries supplying either positive or negative voltage to various equipment. In this case (the Project Ash Can System), the primary separation squib is activated by +24 V and the secondary separation squib is activated by +12 V.

On several past flights the recovery crews have noted that only the secondary tenney device remained on the parachute apex with its squib detonated resulting in the loss of the primary separation tenney. On 3 April 1975 after the instrumentation checks for H75-23/H57 were completed I decided to examine this situation by setting up the system on the ground. The primary and secondary instrumentation

was set up with all their interconnecting cables. Power supplies were substituted for the batteries. A 63-ft diam parachute (SN 2022) with its control cable was connected to the primary control cable which is equivalent to what is commonly referred to as a "bar cable." Two tenney separation devices were attached to the proper connectors at the parachute apex.

These tenney devices were secured from LCD C&I. They were requested with the instructions that the preparation should be the same as that for an active flight except that one squib per device was adequate. Prior to attaching the devices to the parachute cable it was noted that on each device the dark blue wire was attached to the body of the device for a "ground" connection. This is the normal procedure at LCD.

The parachute and its cable were run out of the building and the two tenney devices were covered with a heavy steel can to avoid injury or damage and to deaden the noise. Power was applied to the instrumentation and primary termination was commanded. Both squibs, one in each device, detonated. When the connectors on the tenney devices were opened and the wiring inspected, it was determined that each connector was wired backwards. Pin A is normally "ground" and pin B is normally "grounded" then switched to a positive potential via a relay. Pin A should receive the dark blue wires and pin B should receive the light green wires from the squibs. These were reversed. Therefore, when power was applied to the wires at the instrumentation there was a "short-circuit" at the tenney where it was connected to the "ground" side of the cable. When the tenney release devices were rearmed with properly wired squibs and the experiment rerun the results were as expected; that is, the primary squib detonated and did not effect the secondary squib which was then detonated through the backup controller.

On flight H75-25/H-59, when both tenney devices were wired correctly, the primary tenney was not found with the parachute and the backup was fired.

### K3. MODEL OF SQUIBS AND CABLES

The preceding events precipitated an investigation into the paths available for current supplied by either of the control systems. The squib detonating arrangement is shown in Figure K1. The left side of the drawing represents the end of the cable where it terminates in the two controllers. The right side of the drawing contains the two tenney release devices and their squibs:  $R_s$ . The resistors  $R_d$  represent the distributed resistance of all the wires and cables between the squib firing relay and the squibs plus the contact resistance of all the connector pins between the various cables. The resistor  $R_c$  represents the contact resistance of the surfaces of the two tenney devices and their connecting clevis.

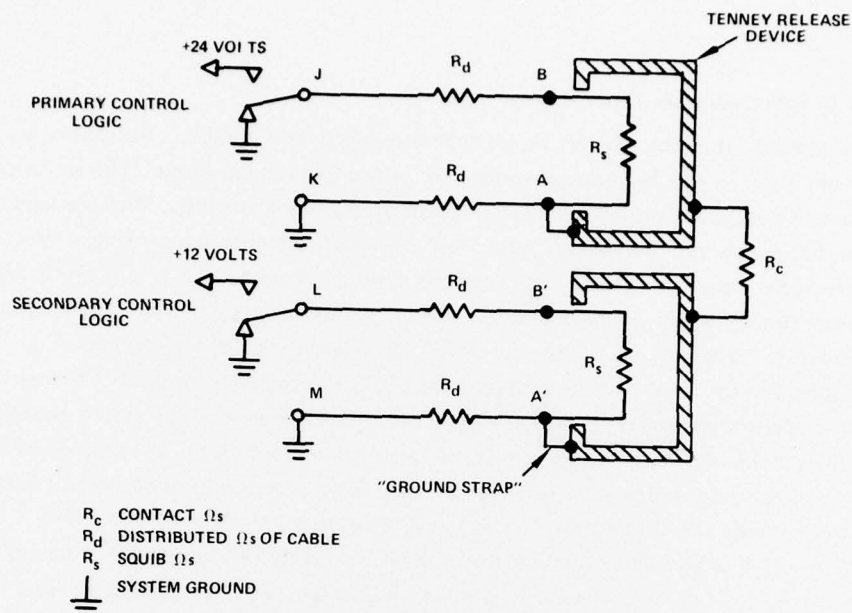


Figure K1. Model of Primary and Secondary Release Devices

#### K4. CALCULATION OF RESISTANCE VALUES

The resistance of one DuPont S-68 squib is  $1.37 \Omega$ . Usually two are used in parallel which reduced the resistance to  $0.685 \Omega$ . For the purposes of this analysis these values were averaged to facilitate the computations. Therefore  $R_s \approx 1.0 \Omega$ .

The distributed resistance of the cables ( $R_d$ ), was based on a 63-ft diam parachute. The handbook notes that 15 in. of cable will be snaked into each 12 in. of parachute length. This is a ratio of 1.25:1 but my experience indicates that a ratio of 1.5:1 is closer to what is actually used. Since this parachute is 90 ft long it would require about 135 ft of cable to reach from the apex to the confluence point. The 135 ft of parachute cable is A.W.G. No. 16 which results in a resistance of  $0.553 \Omega$ . The cables in the instrumentation packages are about 15 ft long and are constructed of A.W.G. No. 20 wire. Their resistance is therefore about  $0.155 \Omega$ . The contact resistance of the connectors used in the cables is about  $0.003 \Omega$  per pin pair. Their combined resistance is about  $0.015 \Omega$ . Therefore  $R_d$  sum of  $0.553$ ,  $0.155$ , and  $0.015 \Omega$ . To simplify the calculations let's say  $R_d \approx 3/4 \Omega$ .

The resistance  $R_c$  is an unknown. Depending on the cleanliness of the two tenney devices and their connecting clevis, it can vary from about  $0 \Omega$  to numbers large enough to be considered infinite.

#### K4.1 Case 1: Both Connectors Wired Correctly

Let's assume that the circuit is as represented in the sketch. Points A, A', B and B' are pins in the MS series connector at the parachute apex. The primed set is used to designate the connector to the backup tenney device. The connectors are wired the same and correctly: pin A on each connector is connected to the side of the wire pair which is always connected to system ground. This is point K for the primary tenney squib and point M for the secondary tenney squib. Also, each pin A is used to "ground" its tenney device. Each wire which is switched to a positive potential to detonate the appropriate squib is normally grounded through the relay's normally closed contact. This is for protection against static charges.

Let's examine the case where  $R_c$  is so large that there is no interaction between the two circuits and the primary termination mode is activated. The three resistors around the circuit JBAK run to  $2.5 \Omega$  so when the wire attached to point J is switched to +24 V a current of 9.6 A flows until the squib detonates. A current of this magnitude flowing from J to K will cause a voltage 7.2 V to appear across the  $R_d$  between A and K. Therefore point A and the primary tenney device are at +7.2 V until the squib detonates. At that time the point A returns to ground potential because no current is flowing. And, point B is a +24 V until the primary termination sequencer returns the relay to which point J is connected to its relaxed state. Then, point B is returned to ground potential. Two points must be noted. First,  $R_c$  was assumed to be so large that the secondary termination circuit did not enter into the analysis. Second, point A which is commonly referred to as "ground" is obviously not "ground" and when there is a current in the circuit the "ground" strap surely does not keep the primary tenney device at (system) ground potential.

Now let's examine the case where  $R_c$  approaches  $0 \Omega$  and the primary termination mode is activated. Starting at joint J,  $R_d$  and  $R_s$  are still in series, but these two resistances are in series with the parallel combination of (1) the return  $R_d$  between A and K; (2) the return  $R_d$  between A' and M and; (3) the series combination of  $R_s$  and  $R_d$  between A' and L. (Don't forget that  $T_c = 0 \Omega$ ) This parallel combination results in an effective resistance of  $0.31 \Omega$  from point A (or A') to ground. The series resistance from point J to ground is now the  $R_d$  between J and B plus  $R_s$  plus the effective resistance of  $0.31 \Omega$ . This is a resistance of  $2.06 \Omega$  which will result in a current of 11.65 A when J is switched to +24 V. This current will cause a potential of about 3.6 V ( $= 11.65 \text{ A} \times 0.31 \Omega$ ) at point A. When the current which is producing this voltage splits in the current divider formed by the parallel resistance,  $2.06 \text{ A}$  ( $= 3.6 \text{ V} / 1.75 \Omega$ ) will flow through the leg containing the  $R_s$  and  $R_d$  between A' and L. The backup squib represented by  $R_s$  will definitely fire. Several points must be noted. First, for these calculations

$R_c$  is  $0 \Omega$ . Second, depending on the speed of the squib detonations the instrumentation fuses may or may not blow. Third, even though everything was "correct" the primary tenney device will be lost.

In real life, the probability of  $R_c$  being either  $0 \Omega$  or infinite ohms is just about zero. However, it probably could get very close to  $0 \Omega$ . The point is that if the results of the two extremes are known, then it stands to reason that some value of  $R_c$  exists which is the exact point where the "approximate all fire current" for the backup squib(s) represented by  $R_s$  will be present. If  $R_c$  is larger, the squib(s) will not detonate; if  $R_c$  is smaller, the squib(s) will detonate. To get a feel for this value of  $R_c$  let all resistances be  $1 \Omega$  and let the "approximate all fire current" be  $0.6 \text{ A}$  for one S-68 squib. Then,  $R_c = 3-1/9 \Omega$ .

#### K4.2 Case 2: Both Connectors Wired Incorrectly

It is of academic interest to examine the case of both tenney release device squibs wired backwards. The only change in the sketch is to remove the "ground" strap from point A to the tenney device and place it from point B to the device.

Let's assume that  $R_c$  is extremely large. As before the current is  $9.6 \text{ A}$  and point B attains a potential of  $16.8 \text{ V}$  but the tenney device is attached to point B so it is at  $16.8 \text{ V}$ , then  $24 \text{ V}$  until the squib detonates and the relay returns to its relaxed state. The backup squib is unaffected.

The next example is when  $R_c$  is  $0 \Omega$ . Using the same reasoning as before, the total resistance is  $R_d$  between J and B plus the parallel combination of the three legs. This is  $(0.75 \Omega + 0.40 \Omega) = 1.15 \Omega$ . The current through point J when it is switched to  $+24 \text{ V}$  is then  $(24 \text{ V} / 1.15 \Omega) = 20.9 \text{ A}$ . This current results in  $8.3 \text{ V}$  on point B and  $4.8 \text{ A}$  through the backup squib. Both squibs will detonate. The circuit path then changes to a loop comprising points JBB'L. Each  $R_d$  is  $3/4 \Omega$  and  $R_c$  is  $0 \Omega$ . The loop current is therefore  $16 \text{ A}$ . If the initial  $20.9 \text{ A}$  surge did not blow the fuse in series with the  $24 \text{ V}$  supply, then the  $16 \text{ A}$  steady state current will surely blow the fuse. This was verified by the experiment which was recorded above. The value of  $R_c$  for which the exact value of "approximate all fire current" is present is  $7.56 \Omega$ .

#### K4.3 Other Cases

Since the circuit used to model the two methods of separating the parachute from the balloon is symmetrical, the analysis presented above is valid for the similar case of backup termination being enacted while the primary termination system is not operating. However, all current and voltage values will be half those stated above.

Also, it could be assumed that the primary device was wired correctly as the backup device was wired incorrectly or that the reverse situation was applicable. However, I don't feel that these cases would occur because the same person will probably wire both tenney devices. Therefore, they will not be examined.

#### K5. CONCLUSION

The above analysis was undertaken with the belief that incorrectly wiring both tenney device connectors would result in the detonation of the squibs in both the primary and backup tenney devices. It has been shown that both devices will usually be activated upon activation of primary termination regardless of how they are wired if  $R_c$  is of sufficiently low value. The larger currents and higher value for the limiting case of  $R_c$  noted in Case 2, increase the probability of detonating the backup squib if the tenney devices are incorrectly wired.

#### K6. CORRELATION WITH FLIGHT DATA

The system on which this analysis is based is the new LCC backup controller and primary controller. This combination has been flown five times (H74-61/H-53X, H74-65/H-54X, H74-66/H-55X, H75-23/H-57, and H75-25/H-59). Both tenney devices had been activated on four of the five flights. Only on H75-23/H-57 did the recovery crew find the primary tenney device near the parachute. This simultaneous firing of squibs did not occur on earlier flights because the Ash Can Backup Package (see Ash Can Handbook Part II Attachment 10) does not keep the "hot" line to the squib normally grounded. Also, the Range Package II (See handbook page 41) does not keep the backup tenney device squib normally grounded.

#### K7. A SOLUTION

The interaction between the two circuits can be eliminated by making value of  $R_c$  very large. This can be accomplished in real life by inserting a standard 10K pound test nylon loop between the two tenneys. Another clevis may be used with the loop to keep the angular relationships of the two sets of squib leads the same as that flown at present. This additional loop will necessitate moving the parachute cable upward to enable the connector to reach the primary tenney device.

## 8. RECOMMENDATIONS

The above solution should be implemented on future Ash Can flights using the new electronics system. A copy of this memo should be placed in flight folders for the above listed flights.